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ASRB FISHERIES RESOURCE MANAGEMENT
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35. FISHERIES RESOURCE MANAGEMENT

Unit 1. Fisheries Resources

Major fisheries resources of the world and India, global trends in production; Commercially exploited fish and shellfish stocks of India - their distribution, potentials, status, means of exploitation and yields; Target and non-target fisheries resources of the Indian subcontinent and the Exclusive Economic Zone (EEZ); Distribution, composition, trends and dynamics of major exploited fishery resources in hill streams, rivers, reservoirs, lakes, lagoons, estuaries, territorial waters, oceanic waters, deep sea and oceanic islands; Resources associated with open sea and sea mount; Straddling/shared stocks and non-conventional resources; Sport fisheries. Biodiversity, Juvenile exploitation, Bycatch and Discards, Destructive fishing gears and methods.

Unit 2. Fish Biology and Physiology

Biosystematics of commercially important fish, shellfish; Classical and Modern tools in ichthyotaxonomy; Fish phylogeny; Speciation; Fish reproductive biology: Gonado Somatic Index; Fecundity; length at first maturity; Male reproductive system of finfish and shellfish; Female reproductive system of finfish and shellfish; Physiological control of reproduction in finfish, crustaceans and molluscs; Feeding, Developmental biology of commercially important finfish and shellfish; Age and growth studies; Mortality and Recruitment; GIS in resource mapping and forecasting; Monitoring Controlling and Surveillance; Application of tagging and marking in fisheries, Fish migration; Structures and design of fish passes. Modern techniques in fisheries biology: DNA isolation, PCR; DNA barcoding, Meta barcoding, Application of mitochondrial and nuclear markers for genetic stock identification.

Unit 3. Fish Stock Assessment

Concept of fish stock; Distribution and type of stock: unit stock, mixed stock, straddling stock; Characterization and delineation of fish stocks (life history traits, truss network, environmental signals, otolith shapes, genetic analyses); Principle and general procedure of fish stock assessment; features of tropical and temperate fish stocks; Sampling and data collection methods; Indicators and reference points; Carrying Capacity; Recruitment, growth and mortality of fish in natural water bodies; Gear selectivity; Fish stock assessment models - holistic models, analytical models, rapid stock assessment, their advantages and disadvantages; Cohort dynamics; Concept of Maximum Sustainable Yield and Maximum Economic Yield; Prey- predatory models, ECOPATH with ECOSIM; Computer softwares in stock assessment.

Unit 4. Fishing Technology

Different types of fishing crafts and gears, operation and their maintenance; Boat building materials, fishing gear materials, advantages and disadvantages; Evolution of mechanization of crafts in India; Safety measures for the fishing boats; Recent advancements in the construction of active fishing gears; Fishing gears and crafts for deep sea and inland fishing; Green fishing practices; By-catch reduction devices, turtle excluder devices, finfish and shrimp excluder devices; Use of modern techniques and electronic equipment for fish finding, aggregating and capturing; Vessel monitoring system. Fishing Harbours – Types and Components.

Unit 5. Sustainable Fisheries Management

Components and indicators of sustainability; Issues in fisheries - overexploitation, overcapacity, ghost fishing, habitat degradation, damming of rivers, interlinking of rivers, climate change; Reduction of bycatch; Rebuilding fishery/stock; Fishing conflicts - exotic species and their impact, accidental introductions, invasive species, transboundary issues, Illegal, Unreported and Unregulated (IUU) fishing; Traceability certification; Technical guidelines of CCRF for responsible fishing; National and international treaties. Concepts and principles of fisheries management (inland, estuarine and marine); Fisheries biosystems; Indicators and reference points of sustainability; Anthropogenic intervention, stock enhancement and sustainable management approaches in riverine, reservoir, lacustrine, floodplain wetlands and marine fisheries; Modes of fisheries management – open access, regulated, advisory, participatory, user rights; Input control measures - access control and limited entry (size, type, number and power of boats, duration of fishing), licensing, capital investment; Output control measures - total allowable catch, catch quotas, minimum legal size; Technical control measures - size limitations, closed areas, closed seasons, eumetric fishing and mesh size regulations; co-management, right-based fishing, Management of conflicts within sub-sectors in fisheries; alternative livelihood options; Ecosystem based fishery management; Fishing down the food web.

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Unit 6. Aquatic Ecosystem and Restoration

Aquatic habitats – freshwater, estuaries, and marine – their structure, functions, ecological services, productivity and carrying capacity; Trophodynamics and energy flow in aquatic ecosystems, ecological nice, trophic indices and modeling; Plankton and benthos, their role in productivity; Bioindicators, bioaccumulation, bioconentration and biomagnification; Ecological stability and homeostasis; Aquatic pollution and impacts on aquatic resources; Habitat degradation and its impact on fisheries; Synoptic oceanographic analysis – currents, waves, tides, El Nino-southern oscillation; mudbanks, upwelling, downwelling and circulation patterns ocean circulation and fisheries; Fisheries forecasting using environmental parameters; Application of bioprocesses – bioremediation, biomanipulation, bioaugmentaion, biofouling; Influence of environmental parameters on fish abundance, distribution, fish production and resource resilience; harmful effects of algal blooms on fisheries; Ecosystem valuations, Integrated coastal zone management (ICZM); Vulnerability of fishers to natural disasters and coping mechanisms; Artificial Reefs, Fish Aggregating Devices and their uses.

Unit 7. Aquatic biodiversity and conservation

Biodiversity – species, genetic and ecosystem; Biodiversity assessment and indices; Endemic biodiversity; Biomonitoring, bioprospecting and biopiracy, Influence of environmental parameters on fish abundance, distribution, resource resilience; Species concept for conservation related decisions - unique species, umbrella species, flagship species, keystone species, State Fish concept; Threats to fish diversity; biodiversity conservation methods - *ex situ* and *in situ*; IUCN criteria, IUCN-Red List; Participatory approach; Conservation biology- Concept of hotspots. GIS and Remote Sensing, their applications.

Unit 8. Management of ecologically sensitive areas

Ecologically sensitive areas (mangrove, corals, seagrass beds, mudflats and dunes, turtle nesting grounds, horseshoe crab habitat, protected areas, biosphere reserves, salt marshes; freshwater wetlands), their distribution, ecological role, associated fauna and flora – taxonomy, adaptations and biology; Issues, management, regulations and conservation strategies.

Unit 9. Climate change and fisheries

Climate change, causes and its impacts on sensitive aquatic ecosystems, capture fisheries and fish abundance, distribution and physiology; Carbon footprint in fisheries and its impacts on fisheries (temperature rise, ocean acidification, coral bleaching, Ocean acidification; Global ocean circulation; El Nino and Southern Oscillation, IPCC and its reports, UNFCCC, Kyoto Protocol; Global and regional models on climate change and fisheries; Mitigation and adaptation strategies - resilience, vulnerability and risk assessment, institutional mechanisms.

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Unit 10. Fisheries legislations and regulations

Fisheries policies, instruments and mechanisms for fisheries management; Overview of fisheries acts and legislations, revisions and amendments; National policies and regulations – Indian Fisheries Act, The Environmental (Protection) Act; Wildlife protection act, Maritime Zones of India Act, Biodiversity Act, National policy on fisheries, Territorial sea, Contiguous zone, Exclusive Economic and Fishery Zones Act; MFRA, Deep sea fishing policy, Guidelines for deep sea vessels, Coastal Regulation Zone notification, green certification, fish catch certificate, MPEDA Act; International fishery regulations, treaties and instruments – UNCLOS, UNFSA, FAO-CCRF, CITES, CMS, Ramsar Convention, MARPOL, CBD, IWC, IOTC, RFMOs, BOBP, NFDB.

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CHAPTER 01
Fisheries Resources

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2011

1. Which of the following ecological groups of fishes primarily inhabits the water column rather than the ocean floor?
(A) Pelagic fishes
(B) Benthic fishes
(C) Demersal fishes
(D) Epibenthic fishe

2006

2. Under the UNCLOS framework, what is the maximum territorial extent of the Exclusive Economic Zone (EEZ) measured from the coastal baseline?
(A) 12 nautical miles
(B) 24 nautical miles
(C) 200 nautical miles
(D) 350 nautical miles

2010

3. In FAO classifications, the Indian Ocean is divided into which major marine fishing areas?
(A) Area 51 (Western) and Area 57 (Eastern)
(B) Area 31 (Western) and Area 37 (Eastern)
(C) Area 41 (Western) and Area 47 (Eastern)
(D) Area 61 (Western) and Area 67 (Eastern)

2003

4. Identify the INCORRECT statement regarding the current trends in Indian marine capture fisheries.
(A) Production has shifted from traditional non-mechanized to highly mechanized sectors.
(B) Pelagic finfishes constitute the largest share of total marine fish landings.
(C) Overcapacity of fishing fleets is a significant management challenge.
(D) The potential yield estimates are exclusively derived from deep-sea resources.

2025

5. Which of the following statements best describes the yield dynamics of the Indian oil sardine (Sardinella longiceps)?
(A) It exhibits highly stable annual landings uninfluenced by environmental factors.
(B) It shows decadal fluctuations strongly correlated with ENSO and coastal upwelling.
(C) It is exclusively exploited by deep-water trawlers along the east coast.
(D) Its recruitment is entirely independent of sea surface temperature.

2003

6. Which commercially exploited marine demersal resource in India is primarily associated with the family Sciaenidae?
(A) Threadfin breams
(B) Flatfishes
(C) Croakers
(D) Catfishes

2012

7. Among the following marine crustacean resources, which species belongs to the category of non-penaeid shrimps?
(A) Penaeus monodon
(B) Metapenaeus dobsoni
(C) Fenneropenaeus indicus
(D) Acetes indicus

2012

8. Which of the following is the most appropriate classification for cuttlefish within marine molluscan resources?
(A) Cephalopoda
(B) Bivalvia
(C) Gastropoda
(D) Scaphopoda

2016

9. Identify the correct pair of Indian riverine system and its characteristic major exploited species.
(A) Brahmaputra river system - Rastrelliger kanagurta
(B) Ganga river system - Tenualosa ilisha
(C) Godavari river system - Harpadon nehereus
(D) Narmada river system - Schizothorax richardsonii

2013

10. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): Indian reservoirs are broadly classified into small, medium, and large based on

their water spread area.
Reason (R): Small reservoirs generally exhibit lower fish yield potential per hectare compared to large reservoirs.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2010
11. What is the defining characteristic of the Hooghly-Matlah estuarine system's fishery?
(A) It features strong salinity gradients supporting migratory species like Hilsa.
(B) It is a strictly freshwater environment inhabited by Indian Major Carps.
(C) It has no tidal influence, which creates a stable and strictly lacustrine ecology.
(D) It is populated exclusively by deep-sea mesopelagic and bathypelagic fishes.

2016
12. Which of the following species is a major biological indicator of coldwater hill stream fisheries in India?
(A) Labeo rohita
(B) Catla catla
(C) Schizothorax richardsonii
(D) Clarias batrachus

2012
13. Which group of mesopelagic fishes is considered a significant unexploited resource in the deep-sea waters of the Indian EEZ?
(A) Centropomids
(B) Carangids
(C) Lutjanids
(D) Myctophids

2021
14. Which oceanic island ecosystem in India is predominantly recognized for its highly vulnerable coral reef-associated fishery resources?
(A) Majuli Island
(B) Sundarbans
(C) Lakshadweep
(D) Sagar Island

2015
15. Consider the following statements regarding seamount topographies:
I. They act as aggregation sites for pelagic species.
II. They are characterized by low primary productivity.
III. They support high levels of endemism among benthic fauna.
Which of the above statement(s) is/are correct?
(A) I and II
(B) I and III
(C) II and III
(D) I, II, and III

2025
16. What is the primary management framework responsible for regulating highly migratory species such as Tunas in the Indian Ocean?
(A) ICAR
(B) IOTC
(C) CCAMLR
(D) CMFRI

2016
17. Which non-conventional fishery resource is heavily targeted in the Southern Ocean for fishmeal and oil production?
(A) Antarctic krill
(B) Deep-sea squids
(C) Sargassum
(D) Mesopelagic lanternfish

2019
18. Which sport fish is commonly referred to as the "Tiger of Indian Rivers" in recreational fisheries?
(A) Brown Trout
(B) Blue Marlin
(C) Golden Mahseer
(D) Giant Trevally

2008
19. What is the cascading ecological impact of selectively harvesting top predatory fishes from a marine food web?
(A) Proliferation of lower trophic level species
(B) Steady decrease in overall primary productivity
(C) Immediate and total collapse of all trophic levels
(D) Increase in the average size of surviving predators

2010
20. Match the items in List I with those in List II and select the correct option:
List I: (IUCN Category)
P. Critically Endangered
Q. Vulnerable
R. Extinct in the Wild
S. Least Concern
List II: (Definition)

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1. Survives only in captivity or as a naturalized population
2. Widespread and abundant taxa
3. Extremely high risk of extinction in the wild
4. High risk of extinction in the wild

(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-1, S-2
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-4, R-3, S-2

2023

21. Which type of overfishing occurs when fish are harvested at too small a size before they have reached their maximum growth potential?
(A) Recruitment overfishing
(B) Growth overfishing
(C) Ecosystem overfishing
(D) Economic overfishing

2021

22. What is the primary function of a Turtle Excluder Device (TED) in commercial fisheries?
(A) To increase significantly the catch rate of targeted shrimp species
(B) To provide a precise measurement of the current fishing gear depth
(C) To allow marine turtles to escape safely from active trawl nets
(D) To reduce the overall operational fuel consumption of the vessel

2022

23. Which of the following is considered a severe ecological consequence of unmanaged bottom trawling?
(A) Enhanced nutrient cycling in the upper epipelagic zone
(B) Increased abundance of slow-growing deep-sea corals
(C) Reduction in the frequency of harmful algal blooms
(D) Complete destruction of complex benthic habitats

2012

24. Which classification best distinguishes shellfish from finfish?
(A) Shellfish are aquatic invertebrates; finfish are vertebrates.
(B) Shellfish possess a bony endoskeleton; finfish lack them.
(C) Shellfish only inhabit marine zones; finfish are freshwater.
(D) Shellfish are warm-blooded; finfish are strictly cold-blooded.

2022

25. Consider the following statements regarding the EEZ:
I. It grants sovereign rights for exploring and exploiting natural resources.
II. It extends up to 200 nautical miles from the baseline.
III. Coastal states have absolute jurisdiction over international navigation within it.
IV. It was formally established under the 1982 UNCLOS.
Which of the above statement(s) is/are INCORRECT?
(A) I and II
(B) II and III
(C) III only
(D) I and IV

2024

26. Which FAO major marine fishing area represents the Pacific Northwest, historically known for the highest global capture fishery production?
(A) Area 21
(B) Area 61
(C) Area 34
(D) Area 87

2007

27. What is the primary cause of the stagnation in global marine capture fishery production since the late 1990s?
(A) Full or overexploitation of major fish stocks
(B) Rapid expansion of distant water fishing fleets
(C) Global implementation of artificial reef systems
(D) Drastic reduction in global seafood market demand

2004

28. Which Indian inland capture fishery system has seen a significant decline in endemic species due to the construction of barrages and dams?
(A) The Chilka Lagoon
(B) The Andaman Coastal Waters
(C) The Ganga River System
(D) The Vembanad Lake

2004

29. The Indian Mackerel (Rastrelliger kanagurta) predominantly feeds on which of the following?
(A) Benthic polychaetes
(B) Small marine mammals
(C) Hard corals
(D) Phytoplankton and zooplankton

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2024
30. Which marine demersal resource in India frequently exhibits protogynous hermaphroditism, complicating its stock management?
(A) Catfishes (Ariidae)
(B) Flatfishes (Cynoglossidae)
(C) Groupers (Epinephelidae)
(D) Croakers (Sciaenidae)

2003
31. Which of the following is the most significant commercially exploited species of spiny lobster in India?
(A) Scylla serrata
(B) Panulirus polyphagus
(C) Portunus pelagicus
(D) Thenus orientalis

2016
32. Which bivalve resource is extensively cultivated and harvested in Indian coastal waters for marine pearls?
(A) Perna viridis
(B) Crassostrea madrasensis
(C) Meretrix casta
(D) Pinctada fucata

2017
33. The phenomenon of "ghost fishing" is most commonly associated with which abandoned or lost fishing gear?
(A) Gillnets and traps
(B) Cast nets
(C) Hook and line
(D) Harpoons

2014
34. Which migratory route is classically followed by the anadromous Hilsa (Tenualosa ilisha) in the Indian subcontinent?
(A) From freshwater rivers to deep marine trenches for spawning
(B) From estuarine lagoons directly to coral reef ecosystems
(C) From the Bay of Bengal into the Hooghly-Bhagirathi river system for spawning
(D) From Himalayan cold streams to peninsular reservoirs

2009
35. Consider the following statements about natural lakes and reservoirs:
I. Natural lakes have a longer evolutionary history than reservoirs.
II. Reservoirs typically exhibit a dendritic shoreline.
III. Water level fluctuations are generally more extreme in reservoirs.
IV. Natural lakes usually have a higher flushing rate than riverine reservoirs.
V. Reservoirs possess distinct riverine, transitional, and lacustrine zones.
Which of the above statement(s) is/are correct?
(A) I, II, III, and V
(B) II, III, IV, and V
(C) I, III, IV, and V
(D) I, II, III, and IV

2009
36. What is the principal ecological characteristic that defines the fisheries productivity of Chilka Lake?
(A) Its stable hyper-saline environment throughout the year
(B) Its exclusive reliance on groundwater seepage for nutrient loading
(C) Its permanent isolation from the Bay of Bengal
(D) Its seasonal salinity gradient driven by monsoon runoff and tidal influx

2015
37. Which biological adaptation is most characteristic of hill stream fishes like the Snow trout?
(A) Presence of an illicium for prey attraction
(B) Development of specialized adhesive organs or suckers
(C) Extreme reduction of the swim bladder to enhance buoyancy
(D) Hyper-development of the lateral line for deep-sea navigation

2023
38. Deep-sea shrimps, such as Aristeus alcocki, are primarily exploited along which coastal region of India?
(A) The shallow estuarine waters of West Bengal
(B) The intertidal zones of Gujarat
(C) The continental slope off the southwest coast (Kerala)
(D) The coral reefs of Lakshadweep

2021
39. Which of the following best describes the vulnerability of coral reef-associated fisheries in the Andaman & Nicobar Islands?
(A) They are highly resilient to ocean acidification.
(B) They consist of slow-growing species highly susceptible to overexploitation.
(C) They are exclusively composed of daily-

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breeding pelagic species.
(D) They remain completely unaffected by sea surface temperature anomalies.

2002

40. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): Open ocean ecosystems generally exhibit lower primary productivity per unit area compared to coastal upwelling zones.
Reason (R): Open ocean waters are typically depleted of essential nutrients like nitrogen and iron due to thermal stratification.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2011

41. Which of the following billfish species is commonly targeted in Indian sport and commercial fisheries?
(A) Makaira nigricans (Blue Marlin)
(B) Gadus morhua (Atlantic Cod)
(C) Salmo trutta (Brown Trout)
(D) Hippoglossus stenolepis (Pacific Halibut)

2012

42. Under the UN Fish Stocks Agreement, what is the key defining feature of "straddling fish stocks"?
(A) They occur exclusively within the territorial waters of a single nation.
(B) They are purely benthic species that never enter the water column.
(C) They migrate between different national EEZs or into the high seas.
(D) They inhabit only freshwater rivers and adjacent estuaries.

2018

43. Which underutilized marine organism is increasingly recognized for its industrial application in carrageenan and agar production?
(A) Holothurians (Sea cucumbers)
(B) Deep-sea sponges
(C) Antarctic krill
(D) Marine macroalgae (Seaweeds)

2008

44. What is the main objective of using Bycatch Reduction Devices (BRDs) in trawl fisheries?
(A) To increase the total towing time of the net
(B) To sort the catch by value post-harvest
(C) To minimize the incidental capture of non-target species and juveniles
(D) To exclusively exclude marine mammals from the net

2023

45. Which of the following is an example of an entirely destructive and illegal fishing method?
(A) Cyanide fishing
(B) Purse seining
(C) Mid-water trawling
(D) Longlining

2015

46. Identify the correct statement regarding the Bombay Duck (Harpadon nehereus) fishery.
(A) It is a major fishery along the southeast coast of India.
(B) It is a deep-sea benthic species found only below 1000 meters.
(C) It is an anadromous fish that spawns in the Himalayan rivers.
(D) It is predominantly caught using dol nets along the northwest coast of India.

2001

47. Which mathematical concept is primarily used to estimate potential yield in virgin fisheries, traditionally defined by the formula $Y = 0.5 \times M \times B_0$?
(A) Gulland's formula
(B) Beverton-Holt equation
(C) Von Bertalanffy growth function
(D) Ricker recruitment model

2002

48. Identify the INCORRECT pair regarding fishery resource and its habitat.
(A) Threadfin bream - Demersal zone
(B) Indian oil sardine - Pelagic zone
(C) Myctophids - Epipelagic zone
(D) Snow trout - Coldwater streams

2004

49. Which of the following estuarine systems is geographically located on the east coast of India and is known for its high penaeid shrimp production?
(A) Pulicat Lake
(B) Vembanad Lake
(C) Ashtamudi Estuary
(D) Nethravati Estuary

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2013

50. Match the items in List I with those in List II and select the correct option:
List I: (Species Name)
P. Portunus pelagicus
Q. Scylla serrata
R. Panulirus ornatus
S. Penaeus monodon
List II: (Common Name)
1. Mud crab
2. Blue swimming crab
3. Giant tiger prawn
4. Ornate spiny lobster
(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-2, Q-3, R-4, S-1
(D) P-3, Q-1, R-2, S-4

2015

51. The Brahmaputra river system is particularly noted for its rich diversity of which fish group?
(A) Marine catfishes
(B) Deep-sea anglerfish
(C) Coral reef-associated groupers
(D) Ornamental loaches and cyprinids

2025

52. What determines the classification of an aquatic species as "Endemic"?
(A) It is restricted to a specific defined geographic location or habitat.
(B) It has a wide global distribution across all major ocean basins.
(C) It migrates annually between freshwater and marine environments.
(D) It exhibits extremely high fecundity rates compared to other species.

2005

53. Which fishing gear operates on the principle of encircling a school of pelagic fish and then closing the bottom of the net?
(A) Bottom trawl
(B) Drift gillnet
(C) Bottom longline
(D) Purse seine

2018

54. What is a direct consequence of "recruitment overfishing"?
(A) The adult stock is reduced, lacking reproductive capacity for replenishment.
(B) Fish are caught before they reach their maximum growth in weight.
(C) Economic returns from the fishery exceed the maximum sustainable yield.
(D) Ecosystem biodiversity increases due to the removal of apex predators.

2017

55. Select the correct sequence of zones in the marine environment arranged from the surface to the deepest ocean floor.
(A) Epipelagic → Mesopelagic → Bathypelagic → Abyssopelagic
(B) Mesopelagic → Epipelagic → Abyssopelagic → Bathypelagic
(C) Epipelagic → Bathypelagic → Mesopelagic → Abyssopelagic
(D) Abyssopelagic → Bathypelagic → Mesopelagic → Epipelagic

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2022

56. What is the primary cause of periodic oxygen depletion (hypoxia) in highly stratified estuarine fisheries?
(A) Excessive wind mixing of the water column
(B) High rates of photosynthesis by deep-water seaweeds
(C) Eutrophication leading to blooms and bacterial decomposition
(D) The seasonal influx of hyper-oxygenated marine water

2007

57. Which class of finfish possesses a cartilaginous skeleton, lacking true bones?
(A) Chondrichthyes
(B) Osteichthyes
(C) Agnatha
(D) Actinopterygii

2010

58. Identify the exception: All of the following are major commercial bivalve resources exploited in India, EXCEPT:
(A) Mussels (Perna spp.)
(B) Oysters (Crassostrea spp.)
(C) Squids (Loligo spp.)
(D) Clams (Meretrix spp.)

2019

59. Which of the following represents a significant advantage of using square mesh codends instead of diamond mesh codends in trawls?
(A) They increase the capture of all juvenile fishes regardless of size.
(B) They significantly increase the hydrodynamic drag and fuel consumption.
(C) They target explicitly non-commercial benthic invertebrates.
(D) They remain open under tension, allowing

undersized fish to escape.

2008

60. Arrange the following legal maritime zones in the correct order of distance extending seaward from the coastal baseline:

1. Contiguous Zone
2. Exclusive Economic Zone (EEZ)
3. Territorial Sea
4. High Seas

Which of the following represents the correct sequence?

(A) 3, 1, 2, 4
(B) 1, 3, 2, 4
(C) 3, 2, 1, 4
(D) 2, 3, 1, 4

2004

61. Which characteristic defines benthic ecological groups in a fishery context?

(A) They live on or near the seabed and are adapted for a bottom lifestyle.
(B) They actively swim in the upper layers of the open ocean.
(C) They are exclusively freshwater species that inhabit fast-flowing streams.
(D) They migrate vertically every night to feed on phytoplankton.

2014

62. Which deep-sea fishing technique primarily targets mesopelagic fishes such as myctophids?

(A) Shallow water cast netting
(B) Handlining
(C) Demersal longlining
(D) Midwater (pelagic) trawling

2001

63. The concept of "Maximum Sustainable Yield" (MSY) is best described as:

(A) The absolute maximum number of fish caught in a single year without laws.
(B) The minimum catch required to sustain local fishing communities economically.
(C) The total biomass of a fish population prior to any fishing exploitation.
(D) The largest average catch taken from a stock under stable environments.

2014

64. Identify the INCORRECT statement concerning Indian natural lakes.

(A) Wular Lake in Kashmir is a prime example of a natural tectonic lake supporting significant fisheries.
(B) High-altitude natural lakes generally exhibit higher fish production rates than tropical lowland lakes.
(C) Natural lakes often have specialized, endemic fish faunal compositions.
(D) Anthropogenic pollution is a major threat to the ecology of natural lakes in India.

2010

65. Consider the following statements about dynamite fishing:

I. It indiscriminately kills fish, including juveniles and non-target species.
II. It physically shatters the structural complexity of coral reefs.
III. It promotes the rapid regeneration of benthic macrophytes.

Which of the above statement(s) is/are correct?

(A) I and II
(B) II and III
(C) I and III
(D) I, II, and III

2016

66. What major ecological factor drives the spatial distribution of demersal finfishes along the Indian continental shelf?

(A) Wind speed above the sea surface
(B) Lunar phases
(C) Substrate type (mud, sand, or rock)
(D) Cloud cover

2016

67. Which phenomenon significantly contributes to the high fishery productivity of the Malabar upwelling zone?

(A) Sinking of warm, oxygen-rich surface waters
(B) Complete cessation of coastal currents during the monsoon
(C) Upward movement of cold, nutrient-rich deep water to the surface
(D) Heavy reliance on terrestrial leaf litter

2006

68. Which of the following is the least relevant factor in determining the stock-recruitment relationship of a marine fish population?

(A) Spawning stock biomass
(B) Environmental conditions affecting larval survival
(C) Fecundity rates of mature females
(D) The specific color of the adult fish

2003

69. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):

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Assertion (A): Seaweeds are primarily harvested for direct human consumption in India.
Reason (R): Agar and alginate, extracted from seaweeds, have high commercial value in pharmaceutical and food industries.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is false but R is true.
(D) A is true but R is false.

2013
70. What is the defining characteristic of a "straddling stock" as opposed to a "highly migratory species"?
(A) Straddling stocks cross national EEZ boundaries; migratory species traverse oceans.
(B) Straddling stocks only move within a single nation's EEZ.
(C) Highly migratory species are exclusively benthic.
(D) Straddling stocks consist entirely of freshwater species.

2005
71. The "Golden Mahseer" (Tor putitora) is currently classified under which IUCN Red List category due to habitat loss and overfishing?
(A) Least Concern
(B) Near Threatened
(C) Endangered
(D) Extinct

2014
72. Which inland water body type contributes the highest percentage to India's total inland capture fishery production?
(A) High-altitude coldwater lakes
(B) Estuarine lagoons
(C) Rivers and floodplains
(D) Ponds and tanks (culture-based fisheries)

2019
73. Which of the following acts as the primary governing legislation for fisheries within the territorial waters of an Indian coastal state?
(A) The Marine Products Export Development Authority Act
(B) The respective State Marine Fishing Regulation Acts (MFRA)
(C) The Indian Wildlife Protection Act exclusively
(D) The Coastal Regulation Zone (CRZ) Notification

2024
74. Which major marine resource is typically captured using squid jigs equipped with strong artificial lights?
(A) Cuttlefish
(B) Octopus
(C) Deep-sea squids
(D) Mud crabs

2003
75. Consider the following statements about bycatch and discards:
I. Discards refer to the portion of the catch returned to the sea.
II. Bycatch only includes non-commercial species.
III. High discard rates are characteristic of tropical multispecies trawl fisheries.
IV. Survival rates of discarded organisms are generally very high.
Which of the above statement(s) is/are INCORRECT?
(A) I and III
(B) II and IV
(C) I and IV
(D) II and III

NODIA

2004
76. What is the fundamental difference between pelagic and demersal trawl nets?
(A) Demersal nets contact the seabed; pelagic nets operate in the water column.
(B) Pelagic trawls are only used in shallow estuaries.
(C) Demersal trawls are significantly smaller and towed by non-mechanized boats.
(D) Pelagic trawls use square meshes exclusively, while demersal use diamond meshes.

2012
77. Which of the following is an example of an application of the Ecosystem Approach to Fisheries (EAF)?
(A) Maximizing the yield of a single target species regardless of bycatch
(B) Using closed seasons to protect habitat health and trophic balance
(C) Subsidizing fuel to allow unlimited expansion of deep-sea fleets
(D) Encouraging the use of fine-meshed nets to catch all available sizes of fish

2004

78. Which of the following families encompasses the major commercial catfishes exploited in Indian marine waters?
(A) Cyprinidae
(B) Ariidae
(C) Clariidae
(D) Bagridae

2005

79. The exploitation of Antarctic krill (Euphausia superba) is strictly managed by which international organization?
(A) FAO
(B) CCAMLR
(C) IOTC
(D) ICCAT

2017

80. Match the items in List I with those in List II and select the correct option:
List I: (Reservoir)
P. Hirakud
Q. Bhakra Nangal
R. Nagarjuna Sagar
S. Ukai
List II: (River System)
1. Sutlej
2. Mahanadi
3. Tapi
4. Krishna
(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-4, S-3
(C) P-2, Q-4, R-1, S-3
(D) P-3, Q-1, R-4, S-2

2013

81. Which biological feature is uniquely adapted in flatfishes (Pleuronectiformes) for their benthic lifestyle?
(A) Body asymmetry with both eyes migrating to one side during growth
(B) Symmetrical body shape throughout life
(C) Complete loss of fins to facilitate burrowing
(D) Development of a highly rigid external carapace

2012

82. Which level of biodiversity refers to the variety of species within a particular region or ecosystem?
(A) Alpha diversity
(B) Beta diversity
(C) Gamma diversity
(D) Genetic diversity

2003

83. Which Indian coastal region is most prominent for the Bombay Duck fishery?
(A) Saurashtra coast (Gujarat) and Maharashtra
(B) Coromandel coast (Tamil Nadu)
(C) Malabar coast (Kerala)
(D) Lakshadweep archipelago

2005

84. What is the most significant consequence of the capture of gravid (egg-bearing) lobsters?
(A) An immediate increase in the local lobster market price
(B) Severe depletion of the breeding stock and recruitment failure
(C) Enhancement of the genetic diversity of the surviving stock
(D) A decrease in the occurrence of marine diseases

2016

85. Consider the following statements about coral reef fisheries:
I. They exhibit extreme species diversity but low biomass per species.
II. They are highly resilient to physical gear damage.
III. Overfishing of herbivorous fishes can lead to algal overgrowth on reefs.
IV. Target species include groupers, snappers, and ornamental fishes.
V. They are primarily found in temperate, cold-water upwelling zones.
Which of the above statement(s) is/are correct?
(A) I, III, and IV
(B) II, IV, and V
(C) I, II, and III
(D) III, IV, and V

2018

86. Which of the following is a key biological characteristic of cephalopods that makes them highly responsive to fishing pressure?
(A) Extremely long lifespans of 20-30 years
(B) Low fecundity and late sexual maturity
(C) Short lifespans and very rapid growth rates
(D) Protracted larval stages lasting several years

2006

87. The Vembanad Lake in Kerala is famous for supporting a lucrative fishery for which of the following?
(A) Antarctic Krill
(B) Giant freshwater prawn (Macrobrachium rosenbergii)
(C) Deep-sea anglerfish

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(D) Oceanic tunas

2004

88. What is a primary limitation in estimating potential yield using historical catch-effort data?
(A) Catch-effort data perfectly reflects the true abundance of the stock.
(B) It assumes constant catchability, ignoring technological creep.
(C) It requires absolute knowledge of the exact age of every fish caught.
(D) It can only be applied to freshwater aquaculture systems.

2015

89. Which of the following is considered an underutilized marine organism in India, holding potential for bioactive compound extraction?
(A) Marine sponges
(B) Penaeus vannamei
(C) Tenualosa ilisha
(D) Rastrelliger kanagurta

2024

90. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): The use of cyanide in live reef fish trade is heavily condemned globally.
Reason (R): Cyanide stuns the target fish but simultaneously kills coral polyps and destroys the reef habitat.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2014

91. Which of the following gears is classified as a passive fishing gear?
(A) Bottom trawl
(B) Purse seine
(C) Gillnet
(D) Dredge

2002

92. Identify the correct statement regarding the Peninsular rivers of India (e.g., Godavari, Krishna, Cauvery).
(A) They are perennial systems fed continuously by Himalayan glaciers.
(B) They are rain-fed, leading to seasonal flow and fishery yield.
(C) They predominantly support anadromous salmon fisheries.
(D) They remain completely devoid of any carp species.

2012

93. What is the best definition of "Catch Per Unit Effort" (CPUE) in fisheries science?
(A) The total weight of fish caught by an entire nation in a year.
(B) The ratio of catch to effort, used as an index of abundance.
(C) The economic value of the gear divided by the number of fish caught.
(D) The absolute biomass of the virgin stock before fishing commenced.

NODIA

2006

94. The deep-sea fisheries in the Indian EEZ are primarily concentrated at what depth range?
(A) 0 - 50 meters
(B) 50 - 100 meters
(C) 200 - 1000 meters
(D) Below 5000 meters

2009

95. Which type of fishery predominantly exploits the coastal waters of the Andaman & Nicobar Islands?
(A) Small-scale targeting of reef and pelagic species
(B) Mechanized bottom trawling for flatfishes
(C) Industrial drift gillnetting for anadromous species
(D) Extensive aquaculture of Pacific white shrimp

2008

96. Which environmental parameter is most closely monitored to predict the abundance of pelagic shoaling fishes like sardines?
(A) Benthic sediment composition
(B) Deep-sea hydrothermal vent activity
(C) Sea surface temperature and chlorophyll-a concentration
(D) Soil pH of adjacent coastal farmlands

2024

97. Which of the following describes a direct advantage of implementing marine protected areas (MPAs) in territorial waters?
(A) They provide a stock refuge, creating a spillover effect.
(B) They allow for unregulated industrial fishing within their boundaries.
(C) They increase the frequency of ghost fishing.
(D) They guarantee an immediate tenfold

increase in national fishery GDP.

2007

98. What is the primary ecological rationale for banning the use of fine-mesh mosquito nets in coastal estuaries?
(A) They are too expensive for artisanal fishers to purchase.
(B) They capture larvae and juveniles, severely impacting recruitment.
(C) They exclusively catch invasive species.
(D) They bio-accumulate heavy metals from the water column.

2025

99. The "Snow Trout" belongs to which specific family of fishes prevalent in Himalayan drainages?
(A) Cyprinidae (Subfamily Schizothoracinae)
(B) Salmonidae
(C) Cobitidae
(D) Sisoridae

2001

100. Match the items in List I with those in List II and select the correct option:
List I: (System)
P. Hooghly-Matlah
Q. Chilka
R. Pulicat
S. Vembanad
List II: (Characteristic/Location)
1. Largest brackish water lagoon with a distinct mouth connecting to Bay of Bengal (Odisha)
2. Estuarine system of the Ganga delta, influenced by tidal bores
3. Backwater system in Kerala renowned for black clam fishery
4. Second largest lagoon, spanning Andhra Pradesh and Tamil Nadu
(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

2011

101. Which species group constitutes the largest portion of the total catch in global marine capture fisheries?
(A) Small pelagic finfishes (e.g., Anchovies, Herrings, Sardines)
(B) Demersal finfishes (e.g., Cods, Haddocks)
(C) Crustaceans (e.g., Shrimps, Crabs)
(D) Cephalopods (e.g., Squids, Octopus)

2018

102. Which of the following is considered an indicator of ecosystem overfishing?
(A) Persistent decline in the mean trophic level of the catch
(B) An increase in the mean trophic level of the catch over time
(C) Stable inter-annual catches of top predators
(D) An increase in the individual size of target fishes

2011

103. What is the primary functional difference between traditional hook-and-line and longline fishing?
(A) Longlines use a main line with thousands of baited hooks.
(B) Longlining is strictly a recreational method, whereas hook-and-line is industrial.
(C) Longlines are only used in shallow estuaries, hook-and-line in the deep sea.
(D) Longlines never use bait, relying solely on entanglement.

2014

104. Which marine zone represents the water column extending from a depth of 200m to 1000m, characterized by faint light insufficient for photosynthesis?
(A) Mesopelagic zone
(B) Epipelagic zone
(C) Bathypelagic zone
(D) Benthic zone

NODIA

2007

105. Arrange the following taxonomic groups in the correct order of their typical trophic level position in a marine food web:
1. Phytoplankton
2. Zooplankton
3. Planktivorous fish
4. Apex predatory fish
Which of the following represents the correct sequence from lowest to highest?
(A) 1, 2, 3, 4
(B) 2, 1, 4, 3
(C) 1, 3, 2, 4
(D) 4, 3, 2, 1

2013

106. In the context of Indian fisheries, what is a "FAD"?
(A) Fish Aggregating Device, used to attract pelagic fish
(B) Fisheries Allocation Department
(C) Foreign Aid for Deep-sea

(D) Fishery Abundance Dataset

2015

107. Which of the following best defines "Economic Overfishing"?
(A) When fishing effort exceeds the point of Maximum Sustainable Yield (MSY).
(B) When juveniles are harvested before reaching maturity.
(C) When fishing costs exceed the revenue generated from the catch.
(D) When the fishery completely collapses, yielding zero catch.

2017

108. The term "Bycatch" strictly refers to:
(A) Any non-target species captured incidentally during fishing.
(B) Only the targeted commercial species that are retained.
(C) Only the marine mammals caught in fishing nets.
(D) The portion of the catch that is legally sold in international markets.

2005

109. Which major river system of India is severely affected by industrial pollution and water abstraction, deeply impacting its riverine fisheries potential?
(A) The Ganga River
(B) The Zanskar River
(C) The Subarnarekha River
(D) The Lohit River

2006

110. Arrange the following steps of a typical stock assessment process in the correct logical sequence:
1. Formulation of management advice
2. Data collection (catch, effort, biological parameters)
3. Mathematical modeling of stock dynamics
4. Estimation of stock status relative to reference points

Which of the following represents the correct sequence?
(A) 2, 3, 4, 1
(B) 2, 4, 3, 1
(C) 1, 2, 3, 4
(D) 3, 2, 4, 1

2014

111. Identify the INCORRECT statement regarding the spatial zonation of the ocean.
(A) Neritic zone - Water over the continental shelf
(B) Oceanic zone - Open water beyond the continental shelf break
(C) Benthic zone - The ocean floor
(D) Pelagic zone - The sediment layers deep beneath the ocean crust

2019

112. The Indian EEZ encompasses an estimated area of approximately:
(A) 1.02 million sq. km
(B) 2.02 million sq. km
(C) 3.02 million sq. km
(D) 4.02 million sq. km

2019

113. What is the fundamental ecological role of "upwelling" in marine fisheries?
(A) It brings nutrient-rich deep waters to the photic zone.
(B) It permanently traps nutrients in the deep sea.
(C) It causes lethal hyperthermia in coastal fish stocks.
(D) It prevents the migration of demersal fishes.

2017

114. Which oceanic phenomenon is frequently associated with catastrophic declines in the Peruvian anchoveta fishery?
(A) El Niño Southern Oscillation (ENSO)
(B) The Indian Ocean Dipole
(C) The North Atlantic Oscillation
(D) Lunar eclipses

2023

115. Consider the following statements about threadfin breams (Nemipterus spp.):
I. They are an important demersal fishery resource in India.
II. They are extensively used for the production of surimi (minced fish meat).
III. They are strictly herbivorous pelagic fishes.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II, and III

2021

116. The phenomenon of "spawning migration" from marine to freshwater habitats is scientifically termed:
(A) Catadromous migration
(B) Anadromous migration
(C) Amphidromous migration
(D) Oceanodromous migration

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2019
117. Which commercially important cephalopod is characterized by possessing an internal calcareous shell (cuttlebone)?
(A) Cuttlefish
(B) Octopus
(C) Squid
(D) Nautilus

2004
118. Which gear is specifically banned or restricted in many regions due to its immense non-target bycatch, earning the nickname "wall of death"?
(A) Large-scale pelagic driftnets
(B) Handlines
(C) Traditional cast nets
(D) Fish traps

2011
119. What is the primary utility of mapping FAO major marine fishing areas?
(A) To standardize the reporting of global fishery statistics.
(B) To strictly delineate military naval boundaries.
(C) To divide the ocean into privately owned corporate parcels.
(D) To regulate international shipping routes.

2002
120. Identify the correct statement about the reproductive strategy of elasmobranchs (sharks and rays) compared to most teleosts.
(A) Elasmobranchs generally produce millions of small, pelagic eggs.
(B) Elasmobranchs produce few young, making them vulnerable to overfishing.
(C) Elasmobranchs do not reach sexual maturity until they are 50 years old.
(D) Elasmobranchs reproduce exclusively through asexual parthenogenesis.

2008
121. Which aquatic system type is defined by a distinct "riverine", "transitional", and "lacustrine" zone along its longitudinal axis?
(A) A man-made reservoir
(B) A pristine mountain stream
(C) A coastal lagoon
(D) An open ocean gyre

2014
122. Which Indian state historically leads in marine capture fish production, largely due to its extensive continental shelf and upwelling systems?
(A) Gujarat
(B) West Bengal
(C) Odisha
(D) Goa

2007
123. The "Mahseer" group of fishes, pivotal to Indian sport fishing, belongs to which genus?
(A) Tor
(B) Labeo
(C) Channa
(D) Wallago

2023
124. Which of the following is considered an underutilized or non-conventional fishery resource in the deeper waters of the Indian EEZ?
(A) Ribbonfishes
(B) Indian mackerel
(C) Penaeid shrimps
(D) Deep-sea echinoderms and mesopelagic lanternfishes

2001
125. Consider the following statements about Turtle Excluder Devices (TEDs):
I. They consist of a metal grid installed in the trawl net.
II. They guide large objects like turtles out through an escape flap.
III. They are mandatory in Indian shrimp trawl fisheries under specific state regulations.
IV. Their installation results in a 90% loss of target shrimp catch.
Which of the above statement(s) is/are correct?
(A) I, II, and III
(B) I, II, and IV
(C) II, III, and IV
(D) I, III, and IV

NODIA

2018
126. Which of the following best defines "Conservation of genetic resources" in fisheries?
(A) Maintaining the intra-specific genetic diversity of fish stocks.
(B) Cross-breeding all distinct fish stocks to create a single uniform hybrid.
(C) Completely halting all commercial fishing globally.
(D) Modifying the genetic code of wild fishes to increase growth rates.

2015
127. What is a "seamount" in the context of marine topography?
(A) An underwater mountain rising from the

ocean floor.
(B) A shallow coral reef exposed at low tide.
(C) A deep oceanic trench formed by subduction.
(D) An artificial concrete structure deployed for aquaculture.

2004
128. Why do seamounts often support highly productive localized fisheries?
(A) They induce upwelling and Taylors that retain plankton.
(B) They are completely devoid of any oceanic currents.
(C) They consist entirely of massive deposits of terrestrial fertilizers.
(D) They are the exclusive spawning grounds for all freshwater fishes.

2021
129. Identify the exception: All of the following are categorized as threatening aquatic biodiversity, EXCEPT:
(A) Habitat degradation and fragmentation
(B) Introduction of invasive alien species
(C) Implementation of mesh size regulations
(D) Unregulated aquatic pollution

2010
130. Which term refers to the incidental capture of juvenile fish of the target species, before they reach marketable size or maturity?
(A) Economic discard
(B) Bycatch of non-target species
(C) Trophic cascading
(D) Growth overfishing

2011
131. Which estuarine system in India is heavily influenced by the southwest monsoon and features the "Thanneermukkom Bund" which restricts saltwater intrusion?
(A) Chilka Lake
(B) Pulicat Lake
(C) Vembanad Lake
(D) Hooghly Estuary

2006
132. What is the primary factor driving the species composition of estuarine fisheries?
(A) Constant high wave action
(B) The spatial and temporal gradients of salinity
(C) Extreme bathymetric depth
(D) Permanent lack of dissolved oxygen

2002
133. The fishery for "Bombay Duck" is highly unique because the fish is primarily processed by:
(A) Sun-drying on bamboo scaffolds along the beaches
(B) Deep-freezing on board factory ships
(C) Immediate canning in oil
(D) Conversion into live ornamental exports

2025
134. Which of the following species is an example of an introduced exotic species in Indian inland waters that has negatively impacted native fisheries?
(A) Catla catla
(B) Oreochromis mossambicus (Tilapia)
(C) Tor khudree
(D) Etroplus suratensis

2019
135. Consider the following statements on marine crustaceans:
I. Penaeid shrimps release their eggs directly into the water column.
II. Non-penaeid shrimps carry their eggs on their pleopods until hatching.
III. Mud crabs (Scylla spp.) migrate to the open ocean to spawn.
IV. Lobsters generally exhibit a prolonged planktonic larval phase known as a phyllosoma.
V. Crabs lack a true carapace.
Which of the above statement(s) is/are correct?
(A) I, II, III, and IV
(B) II, III, IV, and V
(C) I, III, IV, and V
(D) I, II, and IV only

2015
136. What distinguishes "territorial waters" from the "Exclusive Economic Zone" (EEZ)?
(A) Territorial waters extend to 200 nm, while the EEZ extends to 12 nm.
(B) Sovereignty is absolute in territorial waters; the EEZ is for resources.
(C) Foreign naval vessels can freely exploit resources in territorial waters but not in the EEZ.
(D) Territorial waters are only applicable to inland freshwater lakes.

2025
137. Which of the following is a major constraint in the exploitation of deep-sea fishery resources in India?
(A) High capital investment for vessels and specialized gear

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(B) Lack of any deep-sea fish biomass in the Indian EEZ
(C) Extremely high domestic market demand leading to immediate overfishing
(D) Strict prohibition by the FAO on deep-sea fishing in the Indian Ocean

2016

138. The "Carangidae" family is a major component of Indian marine fisheries. It includes which of the following common groups?
(A) Scads, Trevallies, and Pompanos
(B) Sharks and Rays
(C) Snappers and Groupers
(D) Soles and Flounders

2008

139. Which of the following fishing methods is inherently a "bottom-contact" gear, known for high benthic impact?
(A) Beam trawl
(B) Troll line
(C) Pelagic longline
(D) Lift net

2016

140. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): The assessment of multispecies tropical fisheries is highly complex compared to temperate single-species fisheries.
Reason (R): Tropical fisheries are characterized by continuous spawning, multiple co-existing species with similar physical appearances, and the use of diverse, unselective gears.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2010

141. The global regulation of capture fishery production data and its periodic dissemination is primarily handled by the:
(A) Food and Agriculture Organization (FAO) of the United Nations
(B) World Bank
(C) World Trade Organization (WTO)
(D) International Maritime Organization (IMO)

2005

142. Which oceanic region is synonymous with FAO Major Marine Fishing Area 51?
(A) Western Indian Ocean
(B) Eastern Indian Ocean
(C) Pacific Northwest
(D) Atlantic Southeast

2017

143. Which mathematical model is predominantly used for assessing fish stocks based on length-frequency data in tropical fisheries?
(A) Virtual Population Analysis (VPA) using precise age data
(B) ELEFAN (Electronic LEngth Frequency ANalysis)
(C) Surplus Production Models relying purely on CPUE
(D) The Lotka-Volterra predator-prey model

2014

144. Which of the following defines a "Pulse Fishing" strategy?
(A) Intermittent heavy exploitation followed by recovery periods.
(B) Continuous fishing at MSY levels year-round.
(C) Using electric pulses exclusively to stun target fish.
(D) Fishing only during the full moon phase.

2011

145. What is the primary target species of the Indian coastal "ring seine" fishery, particularly in Kerala?
(A) Oil sardines and mackerel
(B) Deep-sea shrimps
(C) Benthic flatfishes
(D) Large oceanic tunas

NODIA

2008

146. Identify the INCORRECT statement concerning sport and recreational fisheries in India.
(A) Catch-and-release is a heavily promoted conservation practice in sport fishing.
(B) The Golden Mahseer is a highly prized game fish in the Himalayan rivers.
(C) Sport fisheries can generate significant ecotourism revenue for local communities.
(D) Recreational fishing constitutes the largest volume of total fish landings in India.

2016

147. What happens to marine species richness generally as one moves from the equator towards the poles?
(A) It decreases.
(B) It increases significantly.
(C) It remains entirely constant.

(D) It fluctuates unpredictably every season.

2011

148. Which pelagic fish is characterized by its elongated body, prominent beak, and is highly sought after by oceanic longline fleets?
(A) Swordfish (Xiphias gladius)
(B) Skipjack Tuna (Katsuwonus pelamis)
(C) Manta Ray (Mobula birostris)
(D) Ocean Sunfish (Mola mola)

2003

149. In fishery biology, the parameter L_∞ (L-infinity) in the Von Bertalanffy Growth Equation represents:
(A) The exact length of the fish at birth
(B) The theoretical maximum length a fish would reach eventually
(C) The length at which 50% of the population matures
(D) The legal minimum landing size

2017

150. Match the items in List I with those in List II and select the correct option:
List I: (Gear Type)
P. Dol net
Q. Deep-sea longline
R. Bottom trawl
S. Squid jig
List II: (Target/Operational Environment)
1. Demersal finfishes and penaeid shrimps
2. Oceanic tunas and billfishes
3. Bombay duck in strong tidal currents
4. Cephalopods (using light attraction)
(A) P-3, Q-2, R-1, S-4
(B) P-2, Q-3, R-1, S-4
(C) P-3, Q-1, R-2, S-4
(D) P-1, Q-4, R-3, S-2

2005

151. Which is the most productive zone in a deep, stratified freshwater lake?
(A) Epilimnion (photic zone)
(B) Profundal zone
(C) Benthic mud layer
(D) Hypolimnion

2015

152. Which biological phenomenon is severely disrupted by the construction of impassable dams across major rivers?
(A) Longitudinal spawning migrations of fishes
(B) Lunar tidal cycles
(C) The natural occurrence of deep-sea hydrothermal vents
(D) The photosynthetic efficiency of pelagic seaweeds

2005

153. What is the defining physical property of an "estuary"?
(A) A coastal water body where freshwater mixes with seawater.
(B) A completely landlocked hypersaline water body.
(C) A fast-flowing mountain stream before it reaches the plains.
(D) A deep oceanic trench characterized by subduction.

2025

154. Which of the following fish species exhibits true catadromous migration (growing in freshwater, migrating to the sea to spawn)?
(A) Anguilla spp. (Freshwater eels)
(B) Salmo salar (Atlantic salmon)
(C) Tenualosa ilisha (Hilsa)
(D) Tor putitora (Golden Mahseer)

2012

155. Which marine zone is characterized by the absolute absence of solar light, high hydrostatic pressure, and cold temperatures?
(A) Bathypelagic
(B) Epipelagic
(C) Neritic
(D) Photic

2015

156. Which of the following is considered an environmentally non-destructive, highly selective fishing gear when used correctly?
(A) Pole-and-line
(B) Bottom pair trawl
(C) Dynamite
(D) Beam trawl

2021

157. Which group of fishes forms the basis of the highly lucrative specialized export fishery for "surimi" base in India?
(A) Threadfin breams (Nemipterus spp.)
(B) Seer fishes (Scomberomorus spp.)
(C) Carangids
(D) Anchovies

2006

158. Identify the correct pair representing an underutilized resource and its potential use.
(A) Antarctic krill - Fish meal and omega-3 oil extraction

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(B) Myctophids - High value live aquarium export
(C) Corals - Direct human consumption as a staple protein
(D) Sea urchins - Extraction of carrageenan

2024
159. Which marine animal is the primary predator of the "Crown-of-Thorns" starfish, often helping to protect coral reefs from destruction?
(A) Giant Triton (Charonia tritonis)
(B) Bluefin Tuna
(C) Parrotfish
(D) Whale Shark

2023
160. Which of the following gear modifications is specifically designed to reduce the capture of undersized roundfish in a trawl codend?
(A) Using square mesh panels
(B) Adding heavier ground chains
(C) Increasing the engine horsepower of the trawler
(D) Decreasing the overall length of the net

2011
161. The UNCLOS provision relating to "Highly Migratory Species" (Article 64) primarily mandates:
(A) Global cooperation for conservation and management.
(B) Complete cessation of their harvest globally.
(C) Exclusive ownership of these species by the coastal State where they were born.
(D) The mandatory culling of these species to protect smaller pelagic stocks.

2013
162. Which deep-sea crustacean is a major target of specialized deep-water trawlers operating along the continental slope of India?
(A) Solenocera choprai
(B) Metapenaeus monoceros
(C) Penaeus indicus
(D) Scylla serrata

2003
163. What distinguishes the Lakshadweep islands' fisheries from those of the mainland Indian coast?
(A) Pole-and-line fishing for Skipjack Tuna using live bait.
(B) Dominance of mechanized bottom trawling for shrimps.
(C) Complete reliance on riverine carp fisheries.
(D) Extensive harvesting of Bombay Duck.

2019
164. Which biological characteristic is generally associated with "K-selected" marine species (e.g., sharks, marine mammals)?
(A) Late maturity, low fecundity, and long lifespan.
(B) Short lifespan and rapid growth rate.
(C) Early onset of sexual maturity.
(D) High fecundity and no parental care.

2008
165. What is the central premise of the "Stock-Recruitment Relationship" in fisheries science?
(A) Relationship between spawning stock and future recruits.
(B) It models the interaction between different competing fishing fleets.
(C) It predicts the exact daily market price of the recruited fish.
(D) It equates the length of a fish directly to its age in months.

2023
166. Which mathematical formulation assumes that recruitment declines at very high levels of spawning stock biomass due to density-dependent factors (e.g., cannibalism)?
(A) Ricker model
(B) Beverton-Holt model
(C) Von Bertalanffy model
(D) Schaefer surplus production model

2025
167. Identify the INCORRECT statement regarding the Exclusive Economic Zone (EEZ).
(A) It prevents other nations from laying submarine cables.
(B) It provides coastal nations with rights over marine scientific research.
(C) It includes rights to the seabed and its subsoil.
(D) It covers the protection and preservation of the marine environment.

2014
168. Which of the following is considered a primary objective of imposing "closed seasons" (e.g., the monsoon trawl ban) in marine fisheries?
(A) Protecting breeding populations to allow recruitment.
(B) To guarantee an artificial scarcity of fish to drive up market prices.
(C) To strictly prevent traditional fishermen from operating cast nets.
(D) To allow foreign fleets exclusive access to the territorial waters.

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2022
169. What is the fundamental characteristic of "artisanal fisheries"?
(A) Small-scale fisheries with low capital and simple gears.
(B) They are large-scale, highly capitalized operations utilizing factory ships.
(C) They operate exclusively in the high seas beyond national jurisdictions.
(D) They focus strictly on recreational catch-and-release fishing.

2025
170. Which of the following defines the "photic zone" in an aquatic ecosystem?
(A) The upper layer where light allows for photosynthesis.
(B) The deepest layer of a lake where no light penetrates.
(C) The transitional zone where fresh and marine waters mix.
(D) The rocky intertidal zone exposed during low tide.

2014
171. Which cephalopod resource is typically captured using specialized pots or traps, often relying on the animal's natural instinct to seek enclosed shelters?
(A) Octopus
(B) Loligo (Squid)
(C) Sepia (Cuttlefish)
(D) Nautilus

2012
172. The term "Target Catch" refers to:
(A) Specific species a gear is designed and deployed to catch.
(B) All marine organisms incidentally caught and discarded.
(C) The maximum legal quota assigned to a single fishing vessel.
(D) Fish that escape through the meshes of a codend.

2007
173. Which environmental issue is most commonly associated with the excessive application of fertilizers in catchments draining into natural lakes?
(A) Eutrophication leading to algal blooms and fish kills.
(B) Rapid and sustained ocean acidification.
(C) Depletion of the ozone layer over the lake.
(D) Increased tectonic activity forming new lake basins.

2007
174. In the context of fishery biodiversity conservation, what does the IUCN stand for?
(A) International Union for Conservation of Nature
(B) Indian Union for Coastal Navigation
(C) International Unit for Catch Normalization
(D) Institute of Underwater Coral Networks

2015
175. Which Indian estuarine system is characterized by the presence of mangrove-associated fisheries, notably for the mud crab Scylla serrata and various penaeid shrimps?
(A) The Sundarbans (Hooghly-Matlah system)
(B) The Dal Lake
(C) The Narmada Estuary
(D) The Tapi Estuary

2017
176. What is the most critical biological adaptation of deep-sea fishes like Myctophids that aids in their survival and predator avoidance in the mesopelagic zone?
(A) Presence of photophores for bioluminescence.
(B) Complete and permanent loss of visual organs.
(C) Hyper-calcified, extremely dense skeletal bones.
(D) Development of massive air-filled swim bladders to float permanently at the surface.

2002
177. Which metric is considered an absolute measure of fishing effort in a trawl fishery?
(A) Trawling hours multiplied by the engine horsepower.
(B) Total weight of the fish landed.
(C) The ex-vessel price of the shrimp caught.
(D) The specific gravity of the seawater during trawling.

2021
178. What is the term for the legal baseline from which the breadth of the territorial sea and the EEZ is measured?
(A) The Low Water Line on official nautical charts.
(B) The High Water Mark.
(C) The Continental Shelf Break.
(D) The deepest point of the adjacent ocean trench.

2016
179. Identify the correct pair of a marine ecological phenomenon and its direct fisheries consequence.

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(A) Hypoxia (Dead zones) - Mortality of benthic fauna.
(B) Coastal upwelling - Drastic reduction in pelagic fish biomass.
(C) El Niño - Sustained increase in global anchoveta populations.
(D) Thermal stratification - Increased vertical mixing of nutrients.

2024
180. Which of the following is considered an environmentally non-destructive, highly selective fishing gear when used correctly?
(A) Pole-and-line
(B) Bottom pair trawl
(C) Dynamite
(D) Beam trawl

2003
181. What defines "Ecosystem Overfishing"?
(A) Fishing that alters the functioning of the marine ecosystem.
(B) Harvesting a single species beyond its biological limits.
(C) Catching undersized individuals of a target stock.
(D) Fishing operations that fail to make a financial profit.

2002
182. Which non-conventional marine resource is extensively harvested globally for the extraction of agar, a vital phycocolloid used in microbiology and food industries?
(A) Red seaweeds (e.g., Gelidium, Gracilaria)
(B) Brown seaweeds (e.g., Sargassum)
(C) Green seaweeds (e.g., Ulva)
(D) Marine diatoms

2012
183. Identify the INCORRECT statement regarding the life history of penaeid shrimps.
(A) They carry fertilized eggs on pleopods until hatching.
(B) They possess a complex life cycle involving marine and estuarine phases.
(C) Spawning typically occurs in deeper marine waters.
(D) Post-larvae migrate into nutrient-rich estuaries and backwaters to grow.

2018
184. The "Codend" of a trawl net is specifically defined as:
(A) The bag-like section where the catch accumulates.
(B) The very front opening of the net.
(C) The specialized floats attached to the headline.
(D) The heavy metal boards used to keep the net open horizontally.

2019
185. Which Indian freshwater riverine system is characterized by cold, torrential waters and a substrate of boulders and cobbles, perfectly suited for Schizothorax species?
(A) The upper reaches of the Himalayan rivers
(B) The lower reaches of the Godavari
(C) The deltaic region of the Mahanadi
(D) The backwaters of Kerala

2004
186. What is the primary ecological vulnerability of deep-sea fishery resources (e.g., Orange Roughy, Deep-sea sharks) to commercial exploitation?
(A) Slow growth and late maturity make recovery very slow.
(B) They have extremely high natural mortality rates.
(C) They are highly migratory and frequently leave the EEZ.
(D) They are dependent on shallow water estuaries for spawning.

2015
187. Which morphological feature is primarily used by taxonomists to distinguish among different species of Indian major carps?
(A) Shape and orientation of the mouth and lips.
(B) The presence of bioluminescent organs.
(C) The color of the internal swim bladder.
(D) The length of the pectoral fin relative to the total body weight.

2017
188. Which coastal state in India is historically renowned for its rich pelagic fishery dominated by the Indian oil sardine and mackerel?
(A) Kerala
(B) Gujarat
(C) West Bengal
(D) Andhra Pradesh

2005
189. What is the primary driver of the seasonal fluctuation in the salinity of Indian estuaries?
(A) Monsoon freshwater runoff and lunar tidal cycles.
(C) Continuous and unpredictable geothermal activity.
(C) Submarine volcanic eruptions.

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(D) The migration patterns of anadromous fishes.

2011

190. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): Bycatch Reduction Devices (BRDs) are universally adopted by all tropical trawlers without resistance.
Reason (R): BRDs significantly increase the total retained catch and immediate economic revenue for the fishermen.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) Both A and R are false.

2014

191. Which of the following parameters is an essential input for calculating the Maximum Sustainable Yield (MSY) using Surplus Production Models (e.g., Schaefer model)?
(A) Catch and Effort data over several years.
(B) Precise age structure of the population.
(C) Detailed daily stomach content analysis.
(D) Genetic sequencing of the stock.

2018

192. Which phenomenon describes the cascading effect of removing apex predators, leading to an overpopulation of their prey, which in turn depletes lower trophic levels?
(A) Top-down control (Trophic cascade)
(B) Bottom-up control
(C) Lateral advection
(D) Competitive exclusion

2014

193. Which type of fishing vessel is legally prohibited from operating within designated territorial waters (usually 0-12 nm) of most Indian coastal states under their respective MFRAs?
(A) Large mechanized commercial trawlers
(B) Non-mechanized traditional canoes
(C) Small-scale motorized outboard gillnetters
(D) Artisanal hook-and-line vessels

2025

194. The term "Benthos" refers to:
(A) Organisms living on or near the aquatic bottom.
(B) Organisms that actively swim in the pelagic zone.
(C) Microscopic organisms drifting passively with water currents.
(D) Avian species that prey on marine fishes.

2002

195. Which of the following represents an accurate cause-and-effect relationship in reservoir fisheries management?
(A) Water level drawdown disrupts spawning grounds.
(B) Regular stocking of fingerlings; Effect: Immediate collapse of the benthic ecosystem.
(C) Cause: Eutrophication; Effect: Eradication of all aquatic weeds.
(D) Cause: Introduction of invasive predators; Effect: Exponential increase in native species diversity.

2012

196. The "High Seas" are defined under international law as:
(A) Marine areas not included in any State's EEZ.
(B) Only the waters covering the continental shelf.
(C) Any marine area deeper than 2000 meters.
(D) The specific marine zones designated for naval warfare.

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2013

197. Which of the following aquatic organisms is a primary producer in the open ocean ecosystem?
(A) Diatoms (Phytoplankton)
(B) Copepods
(C) Euphausiids (Krill)
(D) Anchovies

2017

198. Which of the following is considered an "Indicator Species" for assessing the health of a coral reef ecosystem?
(A) Butterflyfishes (Chaetodontidae)
(B) Bombay duck
(C) Indian Major Carps
(D) Freshwater mussels

2022

199. What is a "Closed Area" or "Marine Protected Area" (MPA)?
(A) Spatial zones where fishing is restricted for conservation.
(B) A geographical area where all maritime shipping is completely banned.
(C) An area designated exclusively for the dumping of terrestrial waste.
(D) A region of the ocean completely enclosed by

artificial dams.

2018

200. Match the items in List I with those in List II and select the correct option:

List I: (Terminology)

P. Discards

Q. Effort

R. Yield

S. Fecundity

List II: (Definition)

1. The reproductive capacity of a female fish, often expressed as the number of eggs
2. The total weight or number of fish legally landed
3. The quantitative measure of fishing activity applied (e.g., boat days)
4. The portion of the total catch that is thrown back into the sea

(A) P-4, Q-3, R-2, S-1
(B) P-3, Q-4, R-2, S-1
(C) P-4, Q-2, R-3, S-1
(D) P-1, Q-3, R-2, S-4

2025

201. Which specific component of the marine food web acts as the crucial intermediate link transferring energy from phytoplankton to pelagic planktivorous fishes?
(A) Zooplankton
(B) Benthic macroalgae
(C) Apex predators
(D) Detritivorous bacteria

2019

202. Which morphological adaptation is prominent in pelagic fishes like Tunas to facilitate continuous, high-speed swimming?
(A) Lunate caudal fin and streamlined fusiform body.
(B) Dorso-ventrally flattened body.
(C) Complete loss of scales to reduce weight.
(D) Extensive development of bottom-feeding barbels.

2010

203. Identify the INCORRECT statement regarding the life cycle of the Indian Oil Sardine.
(A) It spawns only once in its life (semelparity).
(B) It is a fast-growing, short-lived pelagic fish.
(C) It attains sexual maturity within its first year of life.
(D) Its spawning season coincides predominantly with the southwest monsoon.

2004

204. Which of the following describes the most relevant methodology for determining the age of temperate and some slow-growing tropical fishes?
(A) Counting growth rings on hard structures like otoliths.
(B) Measuring the total length of the fishing vessel.
(C) Analyzing the stomach content composition.
(D) Sequencing the mitochondrial DNA of the gills.

2025

205. Which parameter represents the rate at which fish are removed from a population due to natural causes such as predation, disease, and old age?
(A) Natural Mortality (M)
(B) Fishing Mortality (F)
(C) Total Mortality (Z)
(D) Recruitment Rate (R)

2025

206. Which Indian lake is globally recognized as the largest brackish water lagoon in Asia, famous for its prawn fisheries and as a wintering ground for migratory birds?
(A) Chilka Lake
(B) Wular Lake
(C) Loktak Lake
(D) Sambhar Lake

2012

207. Which Indian Major Carp species is known for having a large upturned mouth and feeding primarily on zooplankton in the surface layer?
(A) Catla catla
(B) Labeo rohita
(C) Cirrhinus mrigala
(D) Labeo calbasu

2001

208. Which destructive fishing method is notoriously associated with bleaching and killing extensive tracts of living coral reefs while targeting live ornamental fish?
(A) Cyanide poisoning
(B) Surface trolling
(C) Midwater trawling
(D) Traditional trap fishing

2008

209. What is the primary function of the lateral line system in fishes?
(A) Detection of water movement and pressure

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gradients.
(B) Excretion of nitrogenous waste.
(C) Digestion of complex marine carbohydrates.
(D) Generation of bioluminescence.

2013
210. Which commercial marine resource relies heavily on the use of specialized "pots" or "traps" baited with trash fish?
(A) Lobsters and Crabs
(B) Oceanic Tunas
(C) Anchovies
(D) Bombay Duck

2024
211. Which region is considered the primary global hotspot for marine biodiversity, encompassing high numbers of endemic coral and reef fish species?
(A) The Coral Triangle (Indo-Pacific)
(B) The Baltic Sea
(C) The Southern Ocean
(D) The Black Sea

2009
212. Which of the following mathematical equations is utilized to describe the length-weight relationship of a fish, typically expressed as $W = aL^b$?
(A) The Allometric Growth Equation
(B) The Logistic Growth Curve
(C) The Gompertz Curve
(D) The Schaefer Equation

2023
213. Identify the INCORRECT pair regarding fishing gear and its specific mechanism of capture.
(A) Longline - Using sonic pulses to stun fish.
(B) Gillnet - Gilling or entanglement of moving fish.
(C) Purse seine - Encirclement of a pelagic school.
(D) Bottom trawl - Active towing over the seabed.

2008
214. Which oceanographic parameter drastically limits the depth distribution of most commercial finfishes in the Arabian Sea?
(A) An intense, intermediate Oxygen Minimum Zone (OMZ).
(B) High surface salinity.
(C) Extremely high sea surface temperatures.
(D) The lack of any continental shelf.

2009
215. The "Maximum Economic Yield" (MEY) of a fishery is conceptually located where on the standard bioeconomic curve?
(A) Effort lower than MSY, maximizing profit margins.
(B) At the exact same point as Maximum Sustainable Yield (MSY).
(C) At the point of absolute maximum physical catch, regardless of operational cost.
(D) At a fishing effort of zero.

2006
216. Which of the following estuarine systems is classified as a "Bar-built estuary"?
(A) Shallow estuary separated by sandbars or barrier islands.
(B) A deep submerged river valley (e.g., Chesapeake Bay).
(C) An estuary formed by glacial scouring (e.g., a fjord).
(D) An estuary formed purely by tectonic faulting.

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2017
217. What is a "Virgin Biomass" (B_0) in fisheries stock assessment?
(A) Biomass estimated before commercial exploitation began.
(B) The biomass consisting entirely of newly hatched larvae.
(C) The total biomass harvested in the very first year of a fishery.
(D) The residual biomass left after a stock has completely collapsed.

2015
218. Which international law/agreement established the formal concept of the 200-nautical-mile Exclusive Economic Zone (EEZ)?
(A) UN Convention on the Law of the Sea (UNCLOS)
(B) The Geneva Convention of 1958.
(C) The Kyoto Protocol of 1997.
(D) The Ramsar Convention of 1971.

2003
219. Which biological metric directly influences a fish population's inherent resilience to heavy fishing pressure?
(A) Intrinsic rate of population growth (r)
(B) The coloration of its scales.
(C) The maximum depth it can dive.
(D) The specific type of parasites it hosts.

2002

220. The "Tuna" family, heavily targeted in the Indian Ocean, is scientifically known as:
(A) Scombridae
(B) Clupeidae
(C) Carangidae
(D) Lutjanidae

2025

221. What is the primary cause of high biological productivity in estuarine ecosystems?
(A) High nutrient inputs from riverine runoff and tidal recycling
(B) Extreme stability of salinity and temperature
(C) Deep water column allowing for multiple photic layers
(D) Lack of competition from marine species

2007

222. Which of the following species is a prominent example of an endemic, endangered species primarily found in the hill streams of the Western Ghats?
(A) Tor malabaricus (Malabar Mahseer)
(B) Tenualosa ilisha
(C) Labeo rohita
(D) Rastrelliger kanagurta

2023

223. What is the primary cause of "Stock Depletion" in open-access marine fisheries?
(A) Tragedy of the Commons via unowned resources.
(B) Strict enforcement of territorial use rights in fisheries (TURFs).
(C) Implementation of highly effective quota systems.
(D) Natural declines due to sunspot activity.

2005

224. Which of the following acts as the fundamental basis for classifying a fishing gear as "Active" or "Passive"?
(A) Whether the gear is towed or remains stationary.
(B) The depth at which the gear is set.
(C) The material the netting is made of (nylon vs. cotton).
(D) The total length of the fishing vessel deploying it.

2005

225. Which of the following is considered an environmentally responsible alternative to bottom trawling for harvesting demersal species?
(A) Demersal longlining or trap fishing
(B) Dynamite fishing
(C) Cyanide application
(D) Bottom dredging

2017

226. What is the primary factor contributing to the high productivity of the Hooghly-Matlah estuarine system?
(A) High influx of nutrient-rich freshwater from major basins.
(B) Complete absence of tidal mixing.
(C) Permanent freezing of the surface waters during winter.
(D) Lack of any adjacent mangrove ecosystems.

2002

227. Identify the INCORRECT statement regarding marine biodiversity conservation.
(A) MPAs are highly ineffective for restoring depleted stocks.
(B) Over-exploitation is a leading driver of biodiversity loss in marine ecosystems.
(C) Habitat destruction significantly threatens coral reef biodiversity.
(D) The IUCN Red List provides a framework for classifying the extinction risk of marine species.

2003

228. Which component of an aquatic ecosystem relies on chemosynthesis rather than photosynthesis for primary production?
(A) Deep-sea hydrothermal vent communities
(B) Coastal kelp forests
(C) Shallow coral reefs
(D) Estuarine mangrove swamps

2018

229. The term "Cohort" in fisheries population dynamics refers to:
(A) A group of fish born during the same spawning season.
(B) All fish currently alive in the ocean.
(C) A specific gear type used to catch multiple species.
(D) The mathematical equation used to calculate mortality.

2005

230. Which of the following directly contributes to "Recruitment Failure" in a fishery?
(A) Excessive harvesting of the mature breeding stock.
(B) Exceptionally favorable environmental conditions for larval survival.
(C) Using highly selective fishing gear that only

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captures mature, post-spawning individuals.
(D) Expanding the total area of protected coastal nurseries.

2021
231. The "Code of Conduct for Responsible Fisheries" (CCRF) was formally adopted by which international organization?
(A) FAO
(B) WTO
(C) Greenpeace
(D) UNEP

2002
232. Which anatomical structure is highly developed in benthic feeding fishes (like goatfishes and some catfishes) for locating prey buried in the sediment?
(A) Sensory barbels located near the mouth.
(B) Enormous eyes adapted for low light.
(C) A highly extended upper jaw.
(D) A lunate caudal fin.

2015
233. What is the fundamental ecological concern with the practice of "Bottom Dredging"?
(A) Severe physical disturbance to the benthic substrate.
(B) It strictly targets pelagic sharks, disrupting the upper water column.
(C) It exclusively captures undersized phytoplankton.
(D) It rapidly cools the sea surface temperature.

2025
234. Which fishery management tool strictly limits the total weight of a particular species that can be legally landed by the entire fleet in a given year?
(A) Total Allowable Catch (TAC)
(B) Minimum Legal Size (MLS)
(C) Individual Transferable Quota (ITQ)
(D) Mesh size regulation

2013
235. The "Penaeidae" family is commercially the most important group of:
(A) Marine prawns/shrimps
(B) Marine finfishes
(C) Marine cephalopods
(D) Freshwater carps

2025
236. Which oceanic feature is characterized by a rapid decrease in temperature with increasing depth?
(A) Thermocline
(B) Halocline
(C) Pycnocline
(D) Barocline

2023
237. Which of the following states possesses the longest coastline in India, significantly influencing its marine capture fishery potential?
(A) Gujarat
(B) Maharashtra
(C) Tamil Nadu
(D) Andhra Pradesh

2015
238. Identify the correct statement about the reproductive biology of major Indian carps (Catla, Rohu, Mrigal) in their natural habitat.
(A) They breed naturally only in flowing riverine environments.
(B) They breed year-round in stagnant pond waters.
(C) They migrate to the ocean to spawn.
(D) They are live-bearers (viviparous).

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2008
239. The term "Pelagic" is derived from a Greek word meaning:
(A) Open sea
(B) Bottom or floor
(C) Estuary or river mouth
(D) Lake

2009
240. Which specific natural hazard severely limits the operational days of traditional fishing fleets on the East Coast of India?
(A) Severe tropical cyclones from the Bay of Bengal.
(B) Frequent and large-scale occurrence of tsunamis.
(C) Persistent freezing of coastal waters in winter.
(D) High-altitude avalanches.

2019
241. Which of the following defines "Mesh Selectivity" in fishing gears?
(A) Property allowing small fish to escape meshes.
(B) The ability of a gear to select fish based purely on their species.
(C) The color of the net that attracts specific fish.
(D) The chemical composition of the netting twine.

2011

242. In India, the regulation of fisheries beyond the territorial waters (12 nm to 200 nm) is under the jurisdiction of the:
(A) Union Government (Central Government)
(B) Respective State Governments
(C) The United Nations Security Council
(D) Local Village Panchayats

2004

243. Which of the following is considered the most reliable biological parameter for distinguishing discrete stocks of a single fish species?
(A) Genetic markers (e.g., microsatellites or mtDNA).
(B) Subtle variations in skin coloration.
(C) Total body length.
(D) Stomach fullness index.

2011

244. What is the primary purpose of constructing "Fish Passes" or "Fish Ladders" on river dams?
(A) To facilitate spawning migrations past the barrier.
(B) To generate hydroelectric power specifically for hatcheries.
(C) To trap fish for easy commercial harvesting.
(D) To completely block invasive species from moving upstream.

2002

245. Which of the following factors is a major cause of the declining fisheries in the Ganga river system?
(A) Water abstraction for irrigation, reducing river flow.
(B) Overstocking of native major carps.
(C) Complete ban on all forms of fishing since 1990.
(D) Excessive deployment of deep-sea trawlers in the upper reaches.

2017

246. The concept of "Carrying Capacity" (K) in an aquatic ecosystem refers to:
(A) Maximum biomass an environment can sustain indefinitely.
(B) The total volume of water a reservoir can hold before breaching.
(C) The maximum tonnage a fishing vessel is legally allowed to transport.
(D) The theoretical point where all fish stocks are driven to extinction.

2005

247. Which mathematical distribution is commonly used to model the probability of capturing fish in a random trapping scenario?
(A) Poisson distribution
(B) Normal distribution
(C) Binomial distribution
(D) Exponential distribution

2014

248. The term "Semelparity" describes a reproductive strategy where an organism:
(A) Reproduces only once and then typically dies.
(B) Reproduces multiple times throughout its lifespan.
(C) Reproduces via asexual fragmentation.
(D) Undergoes sex change from female to male before reproducing.

2021

249. Which of the following is an example of an "Iteroparous" species?
(A) Most perennial reef fishes (e.g., Groupers)
(B) Pacific Salmon
(C) Indian Oil Sardine
(D) Eels

2006

250. Identify the correct statement regarding "Demersal" fishery resources.
(A) Close ecological association with the benthic substrate.
(B) They are entirely unaffected by bottom trawling.
(C) They consist of species living exclusively at the air-water interface.
(D) They only inhabit completely freshwater environments.

2001

251. The "Sargasso Sea" in the Atlantic Ocean is famous as the unique spawning ground for which commercially and culturally important fish?
(A) European and American Eels (Anguilla spp.)
(B) Atlantic Cod
(C) Bluefin Tuna
(D) Atlantic Herring

2005

252. Which of the following best defines "Bioaccumulation" in the context of marine food webs?
(A) Buildup of toxic substances in an organism's tissues.
(B) The rapid digestion of complex carbohydrates

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by detritivores.
(C) The mass aggregation of fish during spawning season.
(D) The deliberate stocking of hatchery-reared juveniles into the wild.

2019
253. What is the fundamental difference between a "lagoon" and an "estuary"?
(A) Estuaries have riverine inflow; lagoons often lack them.
(B) A lagoon is strictly freshwater, while an estuary is hypersaline.
(C) Lagoons are found only in temperate regions; estuaries only in the tropics.
(D) Estuaries are entirely enclosed by land; lagoons are open ocean systems.

2005
254. Which fishing gear represents an active, encircling net operated from the shore, historically significant in Indian coastal fisheries before mechanization?
(A) Shore seine
(B) Pelagic trawl
(C) Deep-sea longline
(D) Benthic dredge

2010
255. The "Otolith" is a biological structure used for aging fish. Where is it located anatomically?
(A) Within the inner ear chamber of a teleost fish.
(B) Embedded in the scales.
(C) Attached to the dorsal fin spine.
(D) Inside the swim bladder.

2006
256. Which of the following equations accurately defines the "Total Mortality" (Z) of a fish stock?
(A) Z = Natural Mortality (M) + Fishing Mortality (F)
(B) Z = Catch + Effort
(C) Z = Recruitment (R) - Growth (G)
(D) Z = Spawning Stock Biomass (SSB) / Yield (Y)

2013
257. What is the primary ecological purpose of designating a specific coastal area as a "No-Take Zone"?
(A) Total prohibition to allow recovery and larval spillover.
(B) To reserve the area exclusively for industrial aquaculture.
(C) To permit only recreational catch-and-release fishing.
(D) To allow unlimited traditional fishing while banning mechanized boats.

2001
258. Which of the following estuarine fishes is known for its extreme tolerance to wide fluctuations in salinity (euryhaline nature)?
(A) Etroplus suratensis (Pearl spot)
(B) Catla catla
(C) Schizothorax richardsonii
(D) Pangasianodon hypophthalmus

2006
259. What is a "Fecundity-Length Relationship" used for in fishery biology?
(A) Determining egg production increases relative to length.
(B) To calculate the swimming speed of a fish based on its length.
(C) To strictly estimate the age of the fish without using otoliths.
(D) To predict the market price of a fish based on its size.

2009
260. The process by which deep, cold, nutrient-rich water is driven toward the surface, replacing water displaced by surface winds, is known as:
(A) Upwelling
(B) Downwelling
(C) El Niño
(D) Tidal bore

2009
261. Which Indian state is geographically associated with the Gulf of Mannar, a significant marine biosphere reserve known for pearl oysters and diverse coral reefs?
(A) Tamil Nadu
(B) Gujarat
(C) Kerala
(D) West Bengal

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2008
262. Which of the following represents an accurate definition of "Catchability Coefficient" (q) in fishery mathematics?
(A) Fraction of stock caught by one unit of fishing effort.
(B) The total market value of the fish landed.
(C) The theoretical maximum size a fish can attain.
(D) The probability of a larva surviving to adulthood.

2014

263. The widespread adoption of synthetic fibers (like nylon) in net making significantly revolutionized fisheries primarily because:
(A) They are rot-resistant, stronger, and less visible.
(B) They rapidly biodegrade, preventing ghost fishing entirely.
(C) They naturally repel all non-target bycatch species.
(D) They are completely cost-free.

2018

264. Which specific type of overfishing describes a scenario where the economic rent (profit) from a fishery is completely dissipated due to excessive effort and capitalization?
(A) Economic overfishing
(B) Recruitment overfishing
(C) Growth overfishing
(D) Ecosystem overfishing

2002

265. What is the "Allee Effect" in population dynamics, a severe concern for heavily depleted fish stocks?
(A) Struggle to find mates at excessively low densities.
(B) Rate increases exponentially at very high densities.
(C) The automatic genetic mutation of a stock in response to pollution.
(D) The rapid migration of an entire stock to a different ocean basin.

2023

266. Which international agreement explicitly outlines the conservation and management of Straddling Fish Stocks and Highly Migratory Fish Stocks?
(A) The UN Fish Stocks Agreement (UNFSA) of 1995
(B) The Kyoto Protocol
(C) The Basel Convention
(D) The CITES Appendices exclusively

2010

267. Identify the correct biological classification for the commercially important "Mud Crab" (Scylla serrata).
(A) Brachyuran crustacean
(B) Macruran crustacean
(C) Bivalve mollusc
(D) Cephalopod

2014

268. Which of the following is considered an intrinsic biological vulnerability of most deep-water sharks to overfishing?
(A) Low fecundity and extremely long gestation periods.
(B) They have extremely high fecundity rates.
(C) They grow rapidly and mature within one year.
(D) They spawn millions of pelagic eggs annually.

2018

269. The "Beverton-Holt" and "Ricker" models are classical mathematical representations of which fundamental fishery dynamic?
(A) Stock-Recruitment relationship
(B) Length-Weight relationship
(C) Gear selectivity ogives
(D) Predator-Prey lotka-volterra equations

2015

270. Which of the following defines a "Yield per Recruit" (Y/R) model in stock assessment?
(A) Examines yield per recruit against mortality levels.
(B) It predicts the total absolute biomass of the stock across all oceans.
(C) It maps the exact migration path of pelagic fishes.
(D) It calculates the economic subsidy required to maintain a fishing fleet.

2011

271. What is the primary ecological risk associated with "Ballast Water" discharge from massive fishing and merchant vessels?
(A) Unintentional introduction of invasive alien species.
(B) Immediate and localized boiling of the seawater.
(C) Complete desalinization of coastal estuaries.
(D) Massive deposition of heavy radioactive metals.

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2002

272. The term "$F_{\{}\max_{\}}$" in a Yield per Recruit curve represents:
(A) Mortality rate producing the maximum yield per recruit.
(B) The fishing mortality rate that drives a stock to immediate extinction.
(C) The natural mortality rate of a virgin stock.
(D) The exact total catch allowed under a quota system.

2004

273. Which of the following factors represents a density-independent impact on a fish population?
(A) Sudden catastrophic water temperature changes.
(B) Intraspecific competition for food.
(C) Outbreak of an infectious disease easily transmitted in crowded schools.
(D) Cannibalism of larvae by adults.

2025

274. Identify the INCORRECT statement concerning "Seaweeds".
(A) They rely exclusively on catching microscopic prey.
(B) They are macroscopic, multicellular marine algae.
(C) They lack true roots, stems, and leaves typical of higher plants.
(D) They are classified primarily into Green, Brown, and Red algae based on pigmentation.

2016

275. Which estuarine characteristic refers to a condition where deeper, higher-salinity marine water forms a distinct layer beneath outflowing, lower-salinity freshwater?
(A) Salt wedge or stratification
(B) Complete vertical mixing
(C) Hypersalinity
(D) Eutrophication

2018

276. The "Schaefer" and "Fox" models are examples of:
(A) Surplus Production (Biomass Dynamic) models
(B) Analytical/Age-structured stock assessment models
(C) Global circulation climate models
(D) Bio-economic profit maximization algorithms

2001

277. Which major gear is used predominantly to exploit the "Bombay Duck" resource along the Gujarat and Maharashtra coasts?
(A) Dol net (a stationary bag net)
(B) Purse seine
(C) Bottom longline
(D) Cast net

2017

278. In terms of marine spatial planning, what does "Zonation" typically aim to achieve within a Marine Protected Area (MPA)?
(A) Dividing the MPA into distinct sectors with protection levels.
(B) Allowing unrestricted industrial fishing everywhere.
(C) Privatizing the ocean floor for mining conglomerates exclusively.
(D) Eradicating all native species to introduce commercial exotics.

2014

279. Which of the following accurately describes the concept of "Fishing Effort"?
(A) Gear quantity used on grounds over a unit of time.
(B) The total number of hours a fish struggles when hooked.
(C) The physical exertion required by an angler to land a fish.
(D) The absolute number of eggs produced by the entire stock.

2023

280. Which of the following best explains why "Coral Reefs" are highly vulnerable to destructive fishing practices like dynamite?
(A) Shattered slow-growing structures take decades to recover.
(B) The corals are fast-growing and recover within days, leading to over-calcification.
(C) Dynamite causes the water to become permanently frozen.
(D) The explosions instantly vaporize the entire water column.

2021

281. The metric "Spawning Stock Biomass" (SSB) is crucial because it indicates:
(A) Total weight of mature, reproducing fish in the stock.
(B) Only the weight of the male fishes in a population.
(C) The total biomass of the discarded bycatch.
(D) The total biomass of phytoplankton available as food.

2001

282. Where is the headquarters of the Central Marine Fisheries Research Institute (CMFRI) located?
(A) Kochi, Kerala
(B) Mumbai, Maharashtra
(C) Barrackpore, West Bengal
(D) Chennai, Tamil Nadu

2009

283. What is the fundamental basis of the "Ecosystem Approach to Fisheries" (EAF)?
(A) Holistic management of species, habitat, and

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humans.
(B) Managing each fish species in complete isolation from its environment.
(C) Maximizing the catch of a single apex predator to eliminate competition.
(D) Banning all human interaction with the marine environment universally.

2013
284. Which oceanic zone lies directly above the continental shelf?
(A) Neritic zone
(B) Oceanic zone
(C) Bathypelagic zone
(D) Abyssal zone

2009
285. The "von Bertalanffy Growth Function" (VBGF) primarily models:
(A) Length increase relative to age toward a maximum.
(B) How fishing effort correlates perfectly with political boundaries.
(C) How the price of fish fluctuates based on lunar cycles.
(D) How many eggs a female will produce based strictly on water salinity.

2005
286. Which of the following accurately describes "Vulnerable Marine Ecosystems" (VMEs)?
(A) Deep-sea environments susceptible to gear damage.
(B) Shallow coastal sandy beaches dominated by resilient seagrasses.
(C) Artificial reefs constructed strictly from sunken tires.
(D) Highly polluted urban estuaries devoid of macrofauna.

2004
287. Which morphological feature characterizes the Order Pleuronectiformes (Flatfishes)?
(A) Laterally compressed, asymmetrical adult body forms.
(B) Perfect bilateral symmetry throughout their entire life.
(C) A cartilaginous skeleton and multiple gill slits.
(D) A complete lack of any fins or scales.

2004
288. In the context of fishing gear technology, what does the "hanging ratio" describe?
(A) The relationship between the length of the netting and the length of the rope it is attached to.
(B) The weight of the lead line compared to the float line.
(C) The speed at which a net sinks in the water column.
(D) The angle of the mesh relative to the horizontal water flow.

2024
289. Which Indian marine finfish resource is known for its distinct "air bladder" (swim bladder), which commands extremely high prices in international markets for the production of isinglass?
(A) Croakers / Jewfishes (Sciaenidae)
(B) Oil Sardine
(C) Bombay Duck
(D) Mackerel

2014
290. Identify the correct pair representing a fishery region and its major climatic driver.
(A) Malabar Coast - Southwest Monsoon induced upwelling.
(B) Coromandel Coast - Deep-sea hydrothermal venting.
(C) Lakshadweep - Glacial meltwater influx.
(D) Ganga Estuary - Hyper-arid desertification.

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2019
291. Which organ in many teleost fishes is primarily used for maintaining neutral buoyancy in the water column?
(A) Swim bladder
(B) Lateral line
(C) Liver
(D) Spleen

2008
292. Which international organization is tasked directly with compiling and publishing the annual "State of World Fisheries and Aquaculture" (SOFIA) report?
(A) Food and Agriculture Organization (FAO)
(B) IUCN
(C) WWF
(D) UNESCO

2019
293. Which of the following is considered an intrinsic, density-dependent mechanism regulating a natural fish population?
(A) Intense intraspecific competition for limited food.
(B) A sudden, unpredicted tsunami.
(C) Changes in global sea surface temperatures due to climate change.

(D) An accidental oil spill from a merchant vessel.

2019

294. What is the primary ecological risk of operating highly selective gears that exclusively target the largest, oldest individuals in a population (BOFFFF hypothesis)?
(A) Removing BOFFFFs severely damages reproductive potential.
(B) It drastically increases the genetic diversity of the remaining stock.
(C) It causes the remaining smaller fishes to immediately starve.
(D) It makes the water inherently toxic to phytoplankton.

2009

295. Which of the following types of marine organism forms the foundational basis of the calcium carbonate structure of a coral reef?
(A) Scleractinian (stony) corals
(B) Benthic macroalgae
(C) Giant clams
(D) Sponges

2003

296. In fisheries economics, what does the term "Open Access" fishery mean?
(A) Fishery with no entry barriers, causing overexploitation.
(B) A fishery heavily guarded by military forces.
(C) A fishery that strictly requires a highly expensive, non-transferable license.
(D) A fishery entirely enclosed within a private, terrestrial aquaculture pond.

2025

297. Which of the following best defines "Plankton"?
(A) Microscopic organisms drifting passively with currents.
(B) Organisms capable of sustained, independent swimming against strong ocean currents.
(C) Organisms firmly attached to the ocean floor.
(D) Amphibious mammals inhabiting coastal estuaries.

2003

298. Identify the INCORRECT statement regarding the life history of cephalopods (e.g., squids).
(A) They exhibit slow growth compared to demersal finfishes.
(B) They are generally short-lived, with many living for only 1 to 2 years.
(C) They are highly active predators.
(D) Their populations can fluctuate wildly in response to environmental conditions.

2009

299. In fish taxonomy, which term refers to the count of structures such as fin rays, scales, and gill rakers used for species identification?
(A) Meristic characters
(B) Morphometric characters
(C) Cytogenetic markers
(D) Karyotypes

2002

300. According to UNCLOS, the "Contiguous Zone" may not extend beyond how many nautical miles from the baseline?
(A) 12 nautical miles
(B) 24 nautical miles
(C) 48 nautical miles
(D) 200 nautical miles

****

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ANSWERS

1. (A) Pelagic fishes
Marine organisms categorized as pelagic live and feed within the open water column, away from the bottom or shore. These species are adapted for continuous swimming and utilize the vast oceanic environment above the seabed. Unlike benthic or demersal species, their lifecycle and movements are primarily governed by the currents and biological properties of the sea.

2. (C) 200 nautical miles
The Exclusive Economic Zone represents a maritime area where a coastal state holds special rights regarding the exploration and use of marine resources. According to international law, this zone extends from the territorial sea baseline to a distance of two hundred nautical miles. It encompasses the water column and the seabed, allowing for sovereign resource management and conservation.

3. (A) Area 51 (Western) and Area 57 (Eastern)
The Food and Agriculture Organization partitions the global oceans into specific zones to facilitate standardized fishery statistics and reporting. In the Indian Ocean, the western sector is designated as Area 51, while the eastern sector is identified as Area 57. These classifications allow for precise monitoring of catch data and regional management across different marine territories and ecosystems.

4. (D) The potential yield estimates are exclusively derived from deep-sea resources.
Assessment of marine resources involves evaluating various habitats including coastal, shelf, and oceanic regions. Potential yield estimates are calculated using data from diverse ecosystems and depths, rather than focusing solely on deep-sea areas. Modern management challenges in the sector include addressing fleet overcapacity and the shift toward highly mechanized fishing practices to maintain sustainable landing trends.

5. (B) It shows decadal fluctuations strongly correlated with ENSO and coastal upwelling.
The Indian oil sardine is a highly sensitive pelagic species whose population dynamics are closely linked to environmental variables. Variations in sea surface temperature and the intensity of coastal upwelling, often influenced by the El Niño Southern Oscillation, lead to significant annual and decadal changes in landings. Understanding these oceanographic correlations is essential for predicting future fishery yields.

6. (C) Croakers
Members of the family Sciaenidae are commonly referred to as croakers or drumfishes due to the sounds they produce using their swim bladders. These demersal fishes are found along the Indian continental shelf and constitute a significant portion of the bottom-dwelling catch. They are commercially valued for their meat and are frequently targeted by various coastal fishing operations.

7. (D) Acetes indicus
Non-penaeid shrimps are distinguished from penaeids by their reproductive biology, as they carry fertilized eggs on their pleopods until hatching. Acetes indicus is a prominent example of this group and forms a major fishery, particularly along the northwest coast of India. These small crustaceans are vital to the ecosystem and serve as a significant commercial resource.

8. (A) Cephalopoda
Cephalopods are a specialized class of mollusks characterized by bilateral symmetry, a prominent head, and a set of arms or tentacles. Cuttlefishes belong to this group and are recognized for their internal calcareous shells and advanced nervous systems. They are important marine resources exploited globally for their high commercial value and are distinct from bivalves and gastropods.

9. (B) Ganga river system - Tenualosa ilisha
The Ganga river system is a critical habitat for various freshwater and migratory species, most notably the anadromous Hilsa shad. This fish migrates from the sea into the river for spawning, making it a characteristic and highly exploited resource of the region. Proper identification of species-system pairs is fundamental to managing

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riverine biodiversity and maintaining local livelihoods.

10. (C) A is true but R is false.
Reservoirs in India are indeed categorized into small, medium, and large groups based on their total water spread area for management purposes. However, smaller reservoirs generally demonstrate higher fish yield potential per unit area because of higher nutrient levels and more manageable conditions. Therefore, while the classification exists, the claim regarding lower productivity in small systems is incorrect.

11. (A) It features strong salinity gradients supporting migratory species like Hilsa.
The Hooghly-Matlah estuarine system is characterized by complex hydrological interactions between freshwater discharge and tidal seawater influx. This creates varied salinity zones that are essential for the life cycles of many aquatic species. Anadromous fishes, such as the Hilsa shad, utilize these gradients to migrate from the marine environment into freshwater rivers for their spawning activities.

12. (C) Schizothorax richardsonii
High-altitude coldwater ecosystems in India host specialized fish fauna adapted to fast-flowing, oxygen-rich environments. The Snow trout is a key biological indicator for these hill stream fisheries. These fishes possess unique physiological and morphological adaptations, such as specialized mouth parts or adhesive organs, allowing them to thrive and reproduce in the challenging conditions of the Himalayan drainages.

13. (D) Myctophids
Mesopelagic waters within the Indian Exclusive Economic Zone contain vast biomasses of lanternfishes, which belong to the family Myctophidae. These small fishes are characterized by bioluminescent organs and undergo extensive vertical migrations. Although currently underutilized, they represent a significant potential resource for future exploitation, particularly for the production of fishmeal and specialized oils in industrial applications.

14. (C) Lakshadweep
The Lakshadweep archipelago is an oceanic ecosystem comprised of coral atolls that support a wide variety of reef-associated organisms. These fisheries are highly vulnerable because the target species often have slow growth rates and specific habitat requirements. Management of these resources is critical to protect the delicate balance of the reef environment and ensure the long-term sustainability of the islands.

15. (B) I and III
Seamounts are underwater volcanic features that rise from the ocean floor and interact with deep-sea currents to enhance local biological activity. They serve as critical aggregation sites for various pelagic species and support high levels of endemism among bottom-dwelling organisms. Because they often induce localized upwelling of nutrients, they are characterized by high, rather than low, primary productivity.

16. (B) IOTC
The Indian Ocean Tuna Commission is the intergovernmental organization responsible for the management and conservation of tuna and tuna-like species in the region. It coordinates efforts among member nations to ensure that highly migratory stocks are exploited sustainably. This framework is essential for monitoring catch levels, implementing scientific research, and regulating fishing activities across international and national marine boundaries.

17. (A) Antarctic krill
Antarctic krill is a small crustacean that forms a massive biomass in the Southern Ocean, serving as a foundational species for the polar food web. It is targeted by specialized fishing fleets for conversion into fishmeal and high-quality omega-3 oils. Regulation of this resource is strictly managed by international agreements to prevent overexploitation and protect the dependent marine predators.

18. (C) Golden Mahseer
The Golden Mahseer is a highly prized game fish found in the coldwater rivers of the Himalayan foothills. Known for its powerful swimming and size, it is frequently referred to as the tiger of Indian rivers by recreational anglers. Conservation of this species is a priority due to its ecological significance and its role in promoting sustainable ecotourism through sport fishing.

19. (A) Proliferation of lower trophic level species
Removing apex predators from a marine food web disrupts the natural balance of predator-

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prey interactions, often leading to a phenomenon known as a trophic cascade. Without the top-down control provided by these predators, species at lower trophic levels can experience rapid population growth. This imbalance can alter the entire ecosystem structure, affecting biodiversity and the health of the habitat.

20. (A) P-3, Q-4, R-1, S-2
The International Union for Conservation of Nature provides a standardized system for assessing the extinction risk of various taxa. Critically endangered species face an extremely high risk, while vulnerable species face a high risk in the wild. Some taxa survive only in controlled environments, labeled as extinct in the wild, whereas widespread and abundant species are categorized as least concern.

21. (B) Growth overfishing
When fishing pressure is directed at young individuals before they reach an optimal size for harvest, the overall yield from the stock is reduced. This specific type of overfishing prevents fish from achieving their full growth potential, leading to inefficient resource use. It is managed by implementing minimum legal sizes and mesh size regulations to protect smaller individuals in the population.

22. (C) To allow marine turtles to escape safely from active trawl nets
A Turtle Excluder Device is a specialized metal grid integrated into shrimp trawl nets to facilitate the release of large non-target animals. As the net is towed, turtles and other large debris are diverted toward an escape opening, while smaller target species like shrimp pass through the grid. This technology is vital for marine conservation and reducing incidental mortality during fishing.

23. (D) Complete destruction of complex benthic habitats
Bottom trawling involves dragging heavy gear across the seafloor, which can physically alter or destroy the structural complexity of the seabed. This practice often damages deep-sea corals, sponges, and other organisms that provide habitat for numerous species. The resulting loss of benthic diversity and habitat degradation can have long-lasting negative impacts on the overall health and productivity of the ecosystem.

24. (A) Shellfish are aquatic invertebrates; finfish are vertebrates.
In aquatic resource classification, the fundamental distinction is based on the presence or absence of a backbone. Finfish are vertebrates that possess an internal skeleton and gills for respiration throughout their lives. Shellfish, conversely, are invertebrates such as crustaceans and mollusks that often have an external shell or exoskeleton. Both groups are vital components of global capture and culture fisheries.

25. (C) III only
The 1982 United Nations Convention on the Law of the Sea formally established the Exclusive Economic Zone, granting coastal nations sovereign rights over natural resources up to 200 nautical miles. While states have jurisdiction over resource management and research within this zone, they do not possess absolute authority over international navigation. Foreign vessels retain the right of innocent passage and transit.

26. (B) Area 61
The Food and Agriculture Organization uses Area 61 to designate the Northwest Pacific, which is one of the most productive marine regions globally. Historically, this area has yielded the highest volumes of capture fisheries, supported by vast stocks of small pelagics and demersal species. Standardizing these regions allows for effective global monitoring of fish production and regional management of stocks.

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27. (A) Full or overexploitation of major fish stocks
Global marine capture production has leveled off because many of the world's most significant fish populations are being harvested at or beyond their sustainable limits. Although fishing technology and effort have increased, the biological capacity of many stocks to replenish themselves is compromised. Sustainable management and habitat restoration are necessary to address this stagnation and ensure future food security from oceans.

28. (C) The Ganga River System
Human interventions, such as the construction of dams and barrages, have significantly altered the flow and connectivity of the Ganga River. These structures act as physical barriers, disrupting the natural migration routes and spawning activities of many endemic fish species. Consequently, populations of native fishes, including the

iconic Hilsa, have declined, necessitating urgent conservation measures for riverine biodiversity.

29. (D) Phytoplankton and zooplankton
The Indian Mackerel is a prominent pelagic fish that travels in large schools along coastal waters. Its diet primarily consists of microscopic organisms, including various types of phytoplankton and small zooplankton filtered from the water. Because it occupies a lower trophic level, it is an efficient converter of primary and secondary production into biomass, supporting large-scale commercial fisheries in the region.

30. (C) Groupers (Epinephelidae)
Certain marine species, such as groupers, exhibit protogynous hermaphroditism, where individuals begin their lives as females and later transition into males. This reproductive strategy makes them particularly sensitive to fishing pressure, as the selective removal of larger individuals can result in a shortage of males. Fisheries management must account for these complex life histories to prevent reproductive failure and stock collapse.

31. (B) Panulirus polyphagus
Spiny lobsters are high-value crustaceans found in rocky and coral reef habitats along the Indian coast. Among the various species exploited, Panulirus polyphagus is one of the most significant due to its abundance and commercial demand in international markets. These organisms are typically captured using traps, gillnets, or through specialized diving, and require careful management to avoid overharvesting.

32. (D) Pinctada fucata
Marine pearls are produced by certain bivalve species, with Pinctada fucata being the primary resource utilized in Indian waters, particularly around the Gulf of Mannar. These oysters are harvested and cultivated for the production of high-quality gems. Sustainable management of pearl oyster beds is essential to maintain the health of the population and the economic viability of the traditional pearling industry.

33. (A) Gillnets and traps
Ghost fishing occurs when fishing gear, such as gillnets or traps, is lost or abandoned in the aquatic environment but continues to capture and kill organisms. These items remain active for long periods, leading to the unnecessary mortality of target and non-target species. Reducing gear loss and implementing retrieval programs are important strategies to mitigate the ecological impacts of this phenomenon.

34. (C) From the Bay of Bengal into the Hooghly-Bhagirathi river system for spawning
The Hilsa shad is an anadromous species that spends its adult life in the marine environment but migrates into freshwater rivers to spawn. In the Indian subcontinent, large populations move from the Bay of Bengal into major river systems like the Hooghly-Bhagirathi. This migration is timed with environmental cues and is vital for the recruitment of new generations into the fishery.

35. (A) I, II, III, and V
Reservoirs are man-made water bodies that differ from natural lakes in several ways, including their developmental history and physical structure. They typically feature dendritic shorelines and experience more extreme water level fluctuations due to human management. Furthermore, reservoirs exhibit distinct longitudinal zonation, transitioning from riverine to lacustrine environments, whereas natural lakes generally have lower flushing rates and more stable ecological conditions.

36. (D) Its seasonal salinity gradient driven by monsoon runoff and tidal influx
Chilka Lake is a large brackish water lagoon whose ecological health and fishery productivity depend on the mixing of freshwater and seawater. During the monsoon, heavy riverine discharge reduces salinity, while tidal influxes from the Bay of Bengal increase it during other seasons. This dynamic salinity gradient supports a diverse range of species that are adapted to fluctuating estuarine conditions.

37. (B) Development of specialized adhesive organs or suckers
Fishes inhabiting torrential hill streams must withstand strong water currents to avoid being washed away. Many species, including the Snow trout, have evolved specialized morphological features such as adhesive discs or modified mouthparts to cling to rocky substrates. These adaptations allow them to graze on periphyton and navigate the high-energy environments

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characteristic of mountain river systems in the Himalayan region.

38. (C) The continental slope off the southwest coast (Kerala)
Deep-sea shrimps are found at significant depths along the continental slope, where temperatures are lower and environmental conditions are stable. In India, specialized trawling operations target these resources, particularly off the southwest coast in the Quilon bank area. These fisheries require advanced technology and higher operational costs compared to shallow-water shrimping, but they provide access to high-value, underutilized stocks.

39. (B) They consist of slow-growing species highly susceptible to overexploitation.
Coral reef fisheries are characterized by high biodiversity but often involve species with life-history traits that make them vulnerable to intense fishing. Many reef-associated fishes grow slowly, mature late, and have low natural mortality rates. Consequently, even moderate levels of harvest can lead to rapid population declines. Protecting these ecosystems from overfishing and environmental stressors is essential for maintaining marine biodiversity.

40. (A) Both A and R are true and R is the correct explanation of A.
Open ocean environments are often considered biological deserts because they lack the high nutrient concentrations found in coastal zones. Thermal stratification prevents the mixing of nutrient-rich deep water with the sunlit surface layer, limiting the growth of phytoplankton. In contrast, coastal upwelling regions receive a constant supply of nutrients, driving much higher rates of primary productivity and supporting larger fish populations.

41. (A) Makaira nigricans (Blue Marlin)
Billfishes are large, highly migratory pelagic predators characterized by their elongated, sword-like upper jaws. The Blue Marlin is a prominent species within this group and is targeted by both commercial longline fisheries and recreational sport fishing due to its size and strength. These apex predators play a vital role in marine food webs and require international cooperation for effective conservation and management.

42. (C) They migrate between different national EEZs or into the high seas.
Straddling fish stocks are populations that occupy habitats spanning across the boundary between an Exclusive Economic Zone and the adjacent high seas, or between multiple EEZs. Because these species move across legal jurisdictions, their management requires international agreements and cooperation among coastal states and fishing nations. This ensures that exploitation in one zone does not compromise the sustainability of the entire stock.

43. (D) Marine macroalgae (Seaweeds)
Seaweeds are a diverse group of marine plants that are harvested or cultivated for various industrial uses. They are primary sources of phycocolloids such as agar, carrageenan, and alginates, which are used as thickening and gelling agents in the food and pharmaceutical industries. Increasing the sustainable utilization of seaweed resources provides economic opportunities while supporting marine conservation through carbon sequestration and habitat provision.

44. (C) To minimize the incidental capture of non-target species and juveniles
Bycatch Reduction Devices are technical modifications integrated into fishing gear to improve selectivity and reduce the impact on non-target organisms. These devices allow smaller or non-target animals to escape from the net before it is hauled aboard, thereby minimizing waste and protecting biodiversity. Their use is an essential component of sustainable fishery management and helps reduce the ecological footprint of commercial trawling.

45. (A) Cyanide fishing
Certain fishing practices are globally condemned because they cause irreversible damage to marine habitats and indiscriminate mortality of aquatic organisms. Cyanide fishing involves using chemicals to stun fish for the live trade, which simultaneously kills coral polyps and other reef life. Such destructive methods are illegal in most jurisdictions and represent a significant threat to the long-term health and resilience of coral reef ecosystems.

46. (D) It is predominantly caught using dol nets along the northwest coast of India.
The Bombay Duck is a unique marine fish with a high water content, primarily harvested in the

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coastal waters of Gujarat and Maharashtra. The traditional fishery utilizes stationary bag nets known as dol nets, which are set against strong tidal currents to capture the fish. This species is commercially significant and is often processed by sun-drying on specialized scaffolds for long-term storage.

47. (A) Gulland's formula
Gulland's formula is a simplified mathematical tool used by fishery scientists to estimate the potential yield of a fish stock that has not yet been extensively exploited. It relates the yield to the natural mortality rate and the virgin biomass of the population. While more complex models are preferred for managed fisheries, this approach provides a useful baseline for assessing underutilized or new resources.

48. (C) Myctophids - Epipelagic zone
Correct habitat classification is essential for understanding the distribution of marine resources. While sardines are pelagic and threadfin breams are demersal, myctophids are primarily mesopelagic fishes that inhabit the twilight zone of the ocean, typically between 200 and 1000 meters. Although they migrate toward the surface at night, their primary ecological niche is the midwater environment, rather than the sunlit epipelagic zone.

49. (A) Pulicat Lake
Pulicat Lake is a large brackish water lagoon located on the east coast of India, spanning the borders of Andhra Pradesh and Tamil Nadu. It is a productive estuarine system known for its significant landings of penaeid shrimps and various finfishes. The lagoon's ecology is influenced by its connection to the sea and freshwater inflows, making it a vital resource for local fishing communities.

50. (A) P-2, Q-1, R-4, S-3
Marine crustaceans are diverse and commercially valuable, with specific common names associated with their scientific identities. Scylla serrata is known as the mud crab, while Portunus pelagicus is the blue swimming crab. The ornate spiny lobster is scientifically identified as Panulirus ornatus, and Penaeus monodon is the giant tiger prawn. Accurate nomenclature is essential for biological research and the regulation of international trade.

51. (D) Ornamental loaches and cyprinids
The Brahmaputra river system flows through diverse landscapes, creating a wide range of habitats that support a rich variety of freshwater fishes. This region is particularly noted for its high diversity of small, colorful species such as ornamental loaches and various cyprinids. These fishes are ecologically significant and have significant potential in the global aquarium trade, provided they are harvested and managed sustainably.

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52. (A) It is restricted to a specific defined geographic location or habitat.
Endemism refers to the ecological state of a species being unique to a particular geographic area, such as an island, river system, or country. These organisms are not found naturally anywhere else in the world, making them highly vulnerable to habitat loss and environmental changes. Protecting endemic species is a priority in conservation biology to maintain global biodiversity and prevent the loss of unique genetic lineages.

53. (D) Purse seine
Purse seining is a highly efficient method for capturing schooling pelagic fishes like sardines and tuna. The technique involves surrounding a detected fish school with a large wall of netting and then pulling a drawstring to close the bottom of the net, trapping the fish inside. This gear is an active capture method that can yield large catches but requires careful management to avoid bycatch.

54. (A) The adult stock is reduced, lacking reproductive capacity for replenishment.
Recruitment overfishing occurs when the rate of removal of mature individuals is so high that the remaining spawning stock biomass is insufficient to produce enough offspring to maintain the population. This leads to a severe decline in the number of young fish entering the fishery each year. Preventing this condition is a primary goal of fishery management, often achieved through catch limits and protected areas.

55. (A) Epipelagic → Mesopelagic → Bathypelagic → Abyssopelagic
The marine environment is divided into several vertical layers based on depth and light penetration. The uppermost epipelagic zone is sunlit and highly productive. Below this lies the

mesopelagic zone, followed by the bathypelagic and abyssopelagic zones, which are characterized by increasing pressure, decreasing temperature, and a total absence of sunlight. Each zone supports specialized biological communities adapted to its unique physical conditions.

56. (C) Eutrophication leading to blooms and bacterial decomposition
Hypoxia in estuarine environments often results from excessive nutrient loading, which triggers rapid algal growth. When these blooms die, their decomposition by bacteria consumes vast amounts of dissolved oxygen in the water column. This depletion can lead to mass mortality of fish and other aquatic organisms, particularly in stratified systems where vertical mixing is restricted. Managing nutrient runoff is essential to prevent these dead zones.

57. (A) Chondrichthyes
The class Chondrichthyes includes fishes such as sharks, rays, and skates, which are distinguished by a skeleton made primarily of cartilage rather than bone. This structural characteristic differentiates them from the bony fishes, or Osteichthyes. Cartilaginous fishes typically have multiple gill slits and unique reproductive strategies, often producing fewer young but investing more in their survival through various forms of maternal care.

58. (C) Squids (Loligo spp.)
Bivalve mollusks are characterized by having a shell composed of two hinged parts, and major commercial examples in India include mussels, oysters, and clams. Squids, however, belong to the class Cephalopoda and do not possess an external hinged shell. While squids are significant marine resources, they are anatomically and biologically distinct from the sedentary or semi-mobile bivalves found in coastal and estuarine habitats.

59. (D) They remain open under tension, allowing undersized fish to escape.
Square mesh panels or codends are utilized in trawl nets to improve size selectivity and reduce the capture of juvenile fish. Unlike traditional diamond meshes, which can close under tension during towing, square meshes maintain their shape. This allows smaller organisms to pass through the openings and escape the net while still capturing larger, marketable individuals. Such technical modifications are essential for promoting sustainable fishing practices.

60. (A) 3, 1, 2, 4
International maritime law defines several zones extending from the coastal baseline toward the open ocean. The first 12 nautical miles constitute the Territorial Sea, followed by the Contiguous Zone up to 24 miles. The Exclusive Economic Zone extends further to 200 nautical miles from the baseline. Beyond the limits of national jurisdiction lies the High Seas, which are open to all nations for peaceful purposes.

61. (A) They live on or near the seabed and are adapted for a bottom lifestyle.
Benthic organisms inhabit the lowest level of an aquatic body, including the sediment surface and subsurface layers. These species have evolved specialized morphological and physiological traits to thrive in close association with the bottom, such as flattened bodies or specialized feeding organs. They play a critical role in nutrient cycling and serve as important food sources for both demersal and pelagic species.

62. (D) Midwater (pelagic) trawling
Mesopelagic fishes like myctophids inhabit the twilight zone of the ocean during the day and migrate toward the surface at night. Midwater trawling is the primary technique used to exploit these resources because it can be precisely positioned at the specific depths where the fish aggregate. This method allows for the efficient capture of large volumes of small pelagics without disturbing the sensitive benthic environment of the seafloor.

63. (D) The largest average catch taken from a stock under stable environments.
Maximum Sustainable Yield is a fundamental concept in fisheries science representing the theoretical maximum volume of fish that can be harvested from a population over the long term without compromising its ability to replenish. It assumes that the stock remains in a stable environment and that fishing effort is maintained at an optimal level. Achieving MSY is a primary objective for many management frameworks.

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64. (B) High-altitude natural lakes generally exhibit higher fish production rates than tropical lowland lakes.
Natural lakes in India demonstrate a wide range of ecological characteristics, but productivity is typically higher in tropical lowland systems due to warmer temperatures and faster nutrient cycling. High-altitude lakes are often oligotrophic, meaning they have low nutrient levels and slower biological growth rates, resulting in lower fish production. Conservation efforts in all lake types are necessary to address threats such as pollution and habitat alteration.

65. (A) I and II
Blast fishing involves using explosives to stun or kill fish, which is an extremely destructive and illegal practice. It results in indiscriminate mortality across all age groups and species within the vicinity. Furthermore, the shockwaves physically shatter the structural complexity of coral reefs, destroying the essential habitat that supports marine biodiversity. Such methods lead to long-term ecological degradation and the collapse of local fisheries.

66. (C) Substrate type (mud, sand, or rock)
The distribution of demersal species is closely linked to the physical characteristics of the seafloor where they live and feed. Different fishes have specific preferences for substrates such as soft mud, fine sand, or rocky outcrops, which provide varied opportunities for shelter and prey. Mapping these benthic habitats is essential for understanding stock distribution and implementing effective spatial management measures in continental shelf fisheries.

67. (C) Upward movement of cold, nutrient-rich deep water to the surface
Coastal upwelling is an oceanographic process where wind-driven currents displace surface water, allowing deeper, colder, and nutrient-rich water to rise to the photic zone. This influx of nutrients stimulates high rates of primary production by phytoplankton, which in turn supports large populations of pelagic fishes. The Malabar upwelling zone is a prime example, driving the high productivity of sardine and mackerel fisheries along the southwest coast.

68. (D) The specific color of the adult fish
The relationship between the spawning stock and the number of young fish entering the fishery is influenced by several biological and environmental factors. Key determinants include the biomass of mature individuals, the fecundity of females, and the survival rates of larvae, which are affected by oceanographic conditions. Characteristics such as the color of the adult fish are generally irrelevant to the underlying mathematical modeling of population recruitment and dynamics.

69. (C) A is false but R is true.
While some seaweeds are consumed directly by humans in certain regions, the primary commercial focus in India is on their industrial applications. They are harvested mainly for the extraction of phycocolloids like agar and alginate, which are essential ingredients in pharmaceuticals, cosmetics, and the food industry. Therefore, the assertion regarding direct consumption is incorrect, while the reason explaining their high industrial value is factually accurate.

70. (A) Straddling stocks cross national EEZ boundaries; migratory species traverse oceans.
In international maritime law, straddling stocks are those populations whose range extends across the boundary of an Exclusive Economic Zone and the adjacent high seas or another state's EEZ. Highly migratory species, such as tuna, undertake vast transoceanic journeys through many different national and international waters. Both groups require cooperative international management frameworks to ensure that exploitation across different jurisdictions remains sustainable and ecologically sound.

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71. (C) Endangered
The Golden Mahseer is a large and iconic freshwater fish that has experienced significant population declines across its range. Threat factors include habitat fragmentation caused by dams, overfishing, and pollution of its coldwater river habitats. Due to these persistent pressures, the species is currently listed as endangered on the IUCN Red List, highlighting the urgent need for conservation efforts and sustainable management of riverine ecosystems.

72. (D) Ponds and tanks (culture-based fisheries)
Although rivers and estuaries are significant, the largest contribution to India's total inland fishery production comes from culture-based activities in ponds and tanks. These systems

involve the stocking of fast-growing species, such as Indian Major Carps, into managed water bodies. This approach allows for higher yields and more predictable production compared to traditional capture fisheries in open riverine or lagoon environments, supporting food security and rural livelihoods.

73. (B) The respective State Marine Fishing Regulation Acts (MFRA)
In the Indian legal framework, fisheries within territorial waters (up to 12 nautical miles) are under the jurisdiction of the respective coastal state governments. Each state has enacted its own Marine Fishing Regulation Act to manage activities, resolve conflicts between traditional and mechanized sectors, and implement conservation measures like seasonal bans. These acts serve as the primary legal tools for ensuring sustainable resource use within coastal zones.

74. (C) Deep-sea squids
Squids are highly responsive to light, a behavior that is exploited in specialized jigging operations. High-intensity artificial lights are used to attract these cephalopods to the surface, where they are captured using barbed lures called jigs. This method is effective for both coastal and deep-sea species and is a highly selective fishing technique that results in minimal bycatch compared to traditional trawling or netting methods.

75. (B) II and IV
Bycatch encompasses all non-target organisms captured during fishing, which can include both non-commercial and commercial species. Discards are the portion of this catch returned to the sea, and in many tropical trawl fisheries, discard rates can be very high. Unfortunately, many discarded organisms have low survival rates due to physical injury or trauma during capture and handling. Therefore, assertions minimizing bycatch scope or survival impacts are incorrect.

76. (A) Demersal nets contact the seabed; pelagic nets operate in the water column.
Trawl nets are designed according to the habitat of the target species. Demersal trawls are equipped with heavy ground gear to maintain contact with the seafloor and capture bottom-dwelling organisms. In contrast, pelagic or midwater trawls are designed to be towed through the water column without touching the seabed. This distinction is critical for targeting specific fish groups and managing the environmental impact of fishing operations on benthic habitats.

77. (B) Using closed seasons to protect habitat health and trophic balance
The Ecosystem Approach to Fisheries moves beyond single-species management to consider the broader ecological context of fishing. Implementing measures such as seasonal closures helps protect spawning populations and critical habitats, maintaining the balance of the entire marine food web. This holistic strategy aims to ensure that the ecological processes supporting fish production remain functional, thereby providing long-term benefits for both the environment and the fishing industry.

78. (B) Ariidae
Marine catfishes found along the Indian coast primarily belong to the family Ariidae. These fishes are characterized by their smooth, scaleless skin and sensory barbels, and they represent a significant component of the demersal fishery. They are targeted by various gears and are valued for their meat and the production of swim bladders. Understanding their biology and distribution is essential for the effective management of these bottom-dwelling resources.

79. (B) CCAMLR
The Commission for the Conservation of Antarctic Marine Living Resources is the international body tasked with managing the ecosystems of the Southern Ocean. Its mandate includes the regulation of the harvest of Antarctic krill to ensure that the needs of dependent predators, such as whales and penguins, are met. This precautionary approach to management is a model for international cooperation in protecting fragile polar marine environments and their unique biodiversity.

80. (A) P-2, Q-1, R-4, S-3
Major river valley projects in India have created large reservoirs on different river systems to support irrigation, power generation, and fisheries. The Hirakud Dam is situated on the Mahanadi River, while the Bhakra Nangal is on the Sutlej. Nagarjuna Sagar is located on the Krishna River, and the Ukai reservoir is formed on the Tapi. These man-made water bodies are significant resources for inland capture and culture-based fisheries.

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81. (A) Body asymmetry with both eyes migrating to one side during growth
Flatfishes are unique among vertebrates because they undergo a dramatic metamorphosis during their larval stage, where one eye migrates to the other side of the head. This asymmetry allows the adult fish to lie flat on the seafloor with both eyes positioned to scan for prey or predators. This specialized body form is a perfect adaptation for their benthic lifestyle, where they often remain camouflaged in the sediment.

82. (A) Alpha diversity
Biodiversity is measured at different scales to understand ecological complexity. Alpha diversity refers specifically to the variety of species found within a particular habitat or local area. This metric provides a baseline for comparing the richness of different ecosystems and assessing the impacts of environmental changes or human activities. Higher alpha diversity often indicates a more stable and resilient community that can better withstand external pressures.

83. (A) Saurashtra coast (Gujarat) and Maharashtra
The Bombay Duck fishery is highly concentrated along the northwest coast of India, particularly the Saurashtra region of Gujarat and the coast of Maharashtra. These areas provide the specific hydrological conditions, including strong tidal currents, required for the operation of traditional dol nets used to capture this species. The fish is a staple resource for local communities and is widely known for its unique texture and traditional sun-drying processing.

84. (B) Severe depletion of the breeding stock and recruitment failure
Harvesting lobsters that are carrying eggs, often referred to as being in a berried state, directly removes future generations from the population. This practice can lead to a significant decline in the number of recruits entering the fishery, potentially causing a collapse of the stock. Regulations typically prohibit the landing of gravid lobsters to protect the reproductive potential of the population and ensure the long-term sustainability of the resource.

85. (A) I, III, and IV
Coral reef ecosystems are characterized by immense species richness, where many different organisms occupy specialized niches. These fisheries are not resilient to physical damage and can be severely impacted by destructive gears. Overfishing of herbivorous species can disrupt the balance between corals and algae, leading to habitat degradation. Management focuses on protecting these diverse assemblages, which include high-value groups like groupers, snappers, and various ornamental fishes.

86. (C) Short lifespans and very rapid growth rates
Cephalopods, such as squids and octopuses, have biological traits that allow their populations to respond quickly to changes in environmental conditions and fishing pressure. Most species grow very rapidly and complete their life cycle in just one or two years. This high productivity means they can support intense fisheries, but their abundance can also be highly volatile from year to year. Sustainable management must account for these rapid demographic shifts.

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87. (B) Giant freshwater prawn (Macrobrachium rosenbergii)
Vembanad Lake is the largest estuarine backwater system in Kerala and supports a wide variety of commercially important aquatic species. It is particularly renowned for its production of the giant freshwater prawn, which is highly valued for both domestic consumption and export. The lake's unique ecology, influenced by seasonal salinity changes and extensive mangrove and seagrass habitats, provides essential nursery grounds for many crustaceans and finfishes.

88. (B) It assumes constant catchability, ignoring technological creep.
Estimating potential yield based on catch and effort data relies on the assumption that the efficiency of a unit of effort remains the same over time. However, improvements in fishing technology, such as better sonar or GPS, often increase the effectiveness of the gear, a phenomenon known as technological creep. If these changes are not accounted for, assessments may overestimate stock abundance and lead to unsustainable harvest levels being implemented.

89. (A) Marine sponges
Marine sponges are a group of sedentary invertebrates that are increasingly recognized for their potential as sources of unique bioactive compounds. Many of these chemicals have pharmaceutical properties, including antimicrobial and anticancer activities. Although currently underutilized in India, sponges

represent a significant opportunity for the development of new biotechnological products. Sustainable harvesting or mariculture of these organisms could provide economic benefits while supporting marine conservation and scientific research.

90. (A) Both A and R are true and R is the correct explanation of A.
The use of cyanide in the live reef fish trade is globally condemned because it is an inherently destructive practice. The chemical is used to temporarily incapacitate fish for easy capture, but it also acts as a broad-spectrum toxin that kills coral polyps and other sensitive reef organisms. This method leads to the death of the reef structure itself, destroying the essential habitat that supports the entire marine community and its fisheries.

91. (C) Gillnet
Fishing gears are categorized based on whether they are actively moved to capture fish or remain stationary. Passive gears, such as gillnets, are set in the water and depend on the movement of the fish into the gear for capture. This differs from active gears like trawls or purse seines, which are towed or hauled through the water to surround or scoop up the target species. Passive gears often have lower operational energy requirements.

92. (B) They are rain-fed, leading to seasonal flow and fishery yield.
The peninsular rivers of India depend primarily on the seasonal monsoon rains for their water supply, unlike the glacier-fed rivers of the Himalayas. This leads to significant fluctuations in water level and flow throughout the year, which in turn influences the productivity and species composition of the riverine fisheries. These systems support a variety of native carps and catfishes that are adapted to the cyclic changes in their aquatic environment.

93. (B) The ratio of catch to effort, used as an index of abundance.
Catch Per Unit Effort is a critical metric in fisheries science used to estimate the relative abundance of a fish stock. It is calculated by dividing the total catch by the amount of fishing effort applied, such as the number of hours trawled or days fished. A decline in CPUE over time often indicates that the stock is becoming less abundant, serving as an important warning sign for potential overexploitation.

94. (C) 200 - 1000 meters
Deep-sea fisheries within the Indian Exclusive Economic Zone are focused on resources found at significant depths, typically ranging between 200 and 1000 meters. These waters host specialized species such as deep-water shrimps and mesopelagic fishes that are adapted to high pressure and low light. Exploiting these resources requires specialized vessels and gear, and management must address the vulnerability of deep-sea ecosystems to ensure that fishing remains sustainable.

95. (A) Small-scale targeting of reef and pelagic species
The fisheries around the Andaman and Nicobar Islands are characterized by a diverse range of species associated with coral reefs and the surrounding pelagic waters. These activities are predominantly small-scale and utilize traditional or slightly mechanized gears like lines and gillnets. This approach is suited to the complex island topography and the need to protect sensitive reef habitats from more destructive industrial fishing methods like large-scale bottom trawling.

96. (C) Sea surface temperature and chlorophyll-a concentration
Small pelagic fishes, such as sardines and mackerel, are highly responsive to environmental changes in the upper layers of the ocean. Sea surface temperature and the concentration of chlorophyll-a, which indicates the abundance of phytoplankton, are key parameters used to identify productive feeding areas and predict fish movements. Monitoring these variables through satellite remote sensing allows for the identification of potential fishing zones and more effective management of these volatile resources.

97. (A) They provide a stock refuge, creating a spillover effect.
Marine Protected Areas serve as essential conservation tools by providing a safe haven where fish populations can grow and reproduce without interference. As the biomass within the protected area increases, some individuals move into the adjacent fished waters, a phenomenon known as the spillover effect. This helps to replenish depleted stocks, enhance local catches, and protect the overall biodiversity and

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structural integrity of the marine ecosystem for future generations.

98. (B) They capture larvae and juveniles, severely impacting recruitment.
The use of extremely fine-meshed nets, such as mosquito nets, in coastal areas is highly damaging because they capture organisms of all sizes indiscriminately. In nursery habitats like estuaries, these nets remove the larvae and juveniles of many commercially important species before they have a chance to grow or reproduce. This practice severely reduces the number of recruits entering the adult population, leading to the long-term decline of local and regional fisheries.

99. (A) Cyprinidae (Subfamily Schizothoracinae)
Snow trouts are a group of specialized freshwater fishes belonging to the cyprinid subfamily Schizothoracinae. They are native to the high-altitude coldwater rivers of the Himalayan region and are adapted to fast-flowing, oxygen-rich environments. These fishes possess unique morphological features, such as specialized scales and mouthparts, that allow them to thrive in extreme conditions. They are significant components of coldwater fisheries and are important indicators of the health of mountain aquatic ecosystems.

100. (A) P-2, Q-1, R-4, S-3
India's diverse estuarine and lagoon systems support a wide range of fisheries and ecological functions. The Hooghly-Matlah is a tidal-influenced deltaic system, while Chilka is Asia's largest brackish lagoon. Pulicat Lake spans Andhra Pradesh and Tamil Nadu, and Vembanad is a prominent backwater system in Kerala. Each of these water bodies has distinct physical and biological characteristics that define its productivity and the livelihoods of the communities that depend on them.

101. (A) Small pelagic finfishes (e.g., Anchovies, Herrings, Sardines)
Small pelagic fishes occupy the lower levels of the food web and form massive schools in productive coastal and upwelling regions. Due to their high abundance and rapid reproduction, they account for the largest volume of landings in global marine capture fisheries. These species are utilized for direct human consumption and as a primary raw material for the production of fishmeal and oil, making them economically and ecologically vital.

102. (A) Persistent decline in the mean trophic level of the catch
Ecosystem overfishing occurs when fishing pressure alters the overall structure and functioning of the marine community. A key indicator of this phenomenon is a steady decline in the average trophic level of the catch over time, often referred to as fishing down the food web. This happens as top predators are depleted and the fishery shifts toward targeting more abundant, lower-trophic species, potentially leading to long-term ecosystem instability.

103. (A) Longlines use a main line with thousands of baited hooks.
While both methods utilize hooks to capture fish, longlining is a larger-scale commercial technique that involves deploying a long main line with numerous branch lines, each carrying a baited hook. This allows for the simultaneous targeting of many individuals over a wide area or depth range. Longlining is used to catch a variety of species, including oceanic tunas and deep-sea demersal fishes, and is more efficient for industrial-scale operations.

104. (A) Mesopelagic zone
The mesopelagic zone, also known as the twilight zone, extends from depths of 200 to 1000 meters. In this region, light levels are too low to support photosynthesis but sufficient for some organisms to see. It is home to diverse biological communities, including many species that undergo vertical migrations to feed in the upper layers at night. This zone represents a massive, largely underutilized biomass that plays a crucial role in global carbon cycling.

105. (A) 1, 2, 3, 4
Marine food webs are organized into trophic levels through which energy flows from producers to consumers. Phytoplankton are the primary producers that form the base, followed by zooplankton that graze on them. Planktivorous fishes occupy the next level, serving as prey for larger apex predators. Understanding these hierarchical relationships is essential for modeling ecosystem dynamics and assessing the impacts of fishing pressure on different components of the marine environment.

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106. (A) Fish Aggregating Device, used to attract pelagic fish
Fish Aggregating Devices are man-made structures placed in the ocean to attract and concentrate schools of pelagic fish. Many species, particularly tuna and mackerel, naturally congregate around floating objects in the open sea. By using FADs, fishers can increase their catch efficiency and reduce searching time. However, the use of these devices must be regulated to manage their impact on juvenile populations and avoid overexploitation of the target stocks.

107. (C) When fishing costs exceed the revenue generated from the catch.
Economic overfishing occurs when the level of fishing effort is so high that the total costs of operation, including labor and fuel, surpass the total value of the catch. This results in the dissipation of economic rent and can lead to financial instability for fishing communities. Sustainable management aims to maintain effort at a level that maximizes economic yield, ensuring that the fishery remains profitable and viable over the long term.

108. (A) Any non-target species captured incidentally during fishing.
Bycatch refers to the portion of the catch that consists of organisms not specifically targeted by the fishing gear. This can include non-commercial fish species, juveniles of target species, and marine megafauna such as turtles and mammals. High levels of bycatch are a significant conservation concern because they lead to waste and can negatively impact biodiversity. Implementing selective gears and mitigation measures is essential to reduce these incidental impacts in commercial fisheries.

109. (A) The Ganga River
The Ganga River is one of India's most important river systems, but it faces severe ecological challenges from industrial pollution, urban runoff, and heavy water abstraction. These factors have degraded the aquatic habitat, leading to a significant decline in fish diversity and productivity. Conservation efforts must address these anthropogenic stressors to restore the health of the river and ensure the sustainability of the fisheries that support millions of people along its basin.

110. (A) 2, 3, 4, 1
Fishery stock assessment is a systematic process that begins with the collection of comprehensive data on catch, effort, and biological parameters. This information is then used in mathematical models to simulate population dynamics and estimate the current status of the stock. By comparing these results to established reference points, scientists can provide informed management advice to ensure that harvest levels remain sustainable and that the resource is protected for future use.

111. (D) Pelagic zone - The sediment layers deep beneath the ocean crust
The ocean is divided into distinct zones based on physical and biological characteristics. The neritic zone covers the water over the continental shelf, while the oceanic zone refers to the open water beyond it. The benthic zone encompasses the seafloor itself. However, the pelagic zone specifically refers to the entire water column above the seabed, not the sediment layers. Proper understanding of these terms is fundamental to marine ecology and resource management.

112. (B) 2.02 million sq. km
India's Exclusive Economic Zone encompasses an area of approximately 2.02 million square kilometers, providing the nation with sovereign rights over vast marine resources. This zone includes the territorial waters and extends to the limits established under international law. Effective management of this area is critical for national food security, economic development, and the conservation of marine biodiversity across diverse ecosystems ranging from coastal mangroves to deep-sea habitats.

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113. (A) It brings nutrient-rich deep waters to the photic zone.
Upwelling is a vital oceanographic process that occurs when surface waters are displaced by winds, allowing deeper, colder, and nutrient-rich water to rise to the sunlit photic zone. This influx of nutrients stimulates the growth of phytoplankton, which forms the basis of the marine food web. Consequently, upwelling regions are among the most productive areas in the ocean, supporting massive populations of fish and higher trophic level predators.

114. (A) El Niño Southern Oscillation (ENSO)
The El Niño Southern Oscillation is a global climatic phenomenon that significantly alters oceanographic conditions in the Pacific. During an El Niño event, warm surface waters suppress the normal upwelling of nutrient-rich deep water along the coast of South America. This leads to a collapse of primary productivity and a catastrophic decline in the Peruvian anchoveta fishery. Such events highlight the close link between large-scale climatic patterns and regional fishery production.

115. (A) I and II
Threadfin breams are a significant group of bottom-dwelling fishes found along the Indian continental shelf. They are a primary component of the demersal trawl catch and are highly valued for the production of surimi, which is a processed fish protein used in various food products. These fishes are carnivores that feed on small invertebrates and other fishes, rather than being herbivorous pelagic species as incorrectly suggested in some alternative descriptions.

116. (B) Anadromous migration
Anadromous migration occurs when fishes spend most of their adult lives in the marine environment but move into freshwater rivers to spawn. This strategy allows the young to develop in protected, nutrient-rich inland waters before returning to the sea. The Hilsa shad is a classic example of an anadromous species in the Indian subcontinent. Such migrations are critical for the life cycle and require unimpeded river connectivity to ensure successful recruitment.

117. (A) Cuttlefish
Cuttlefishes are a group of cephalopods distinguished by the presence of an internal, porous, calcareous shell known as the cuttlebone. This structure provides buoyancy control and structural support for the animal. Cuttlefishes are highly valued marine resources, targeted by various fishing gears for their meat. They are also known for their sophisticated camouflage abilities and complex behaviors, making them a significant component of both commercial fisheries and marine ecological studies.

118. (A) Large-scale pelagic driftnets
Large-scale pelagic driftnets are notorious for their lack of selectivity and the immense amount of non-target bycatch they generate. These nets can extend for many kilometers, entangling a wide variety of marine life, including dolphins, turtles, and sharks, leading to their description as walls of death. Due to their severe ecological impact, many international and national regulations have banned or strictly limited their use to protect marine biodiversity and ensure sustainable fishing.

119. (A) To standardize the reporting of global fishery statistics.
The Food and Agriculture Organization has established major marine fishing areas to provide a consistent framework for the collection and analysis of fishery data worldwide. These standardized zones allow for the comparison of catch statistics across different regions and time periods, facilitating global monitoring of fish stocks and production. This information is essential for developing international management strategies and ensuring the long-term sustainability of the world's marine resources.

120. (B) Elasmobranchs produce few young, making them vulnerable to overfishing.
Elasmobranchs, including sharks and rays, have a life history strategy that differs significantly from most bony fishes. They generally exhibit slow growth, late maturity, and low fecundity, often producing only a small number of well-developed offspring. This K-selected strategy makes them highly vulnerable to fishing pressure, as their populations cannot recover quickly from high levels of mortality. Conservation efforts for these species are critical to prevent their extinction and maintain ecosystem balance.

121. (A) A man-made reservoir
Reservoirs are artificial water bodies that display a characteristic longitudinal gradient in their physical and biological properties. The upstream riverine zone is followed by a transitional zone, which eventually gives way to a deeper, more stable lacustrine zone near the dam. This zonation influences the distribution of nutrients, plankton, and fish species, requiring specialized management strategies compared to natural lakes or open riverine systems to optimize fishery production and habitat health.

122. (A) Gujarat
Gujarat historically leads India in marine capture fish production due to its extensive coastline and

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wide continental shelf. The region's productivity is further enhanced by oceanographic processes like seasonal upwelling, which support large populations of various pelagic and demersal species. The state's well-developed fishing infrastructure and diverse fleet allow for the exploitation of a wide range of resources, making it a critical contributor to the national economy and food security.

123. (A) Tor
The Mahseer group consists of several species of large, powerful freshwater fishes belonging to the genus Tor. These fishes are highly prized by recreational anglers for their strength and are often called the tigers of Indian rivers. They inhabit the pristine, fast-flowing waters of mountain streams and large rivers. Conservation of the genus Tor is a priority, as many species are threatened by habitat loss, dams, and overfishing across their native range.

124. (D) Deep-sea echinoderms and mesopelagic lanternfishes
The deeper waters of the Indian Exclusive Economic Zone harbor vast amounts of biomass that are currently underutilized. These include various mesopelagic lanternfishes and certain deep-sea invertebrates like echinoderms. Although they are not traditional targets for human consumption, these resources have significant potential for industrial uses, such as the production of animal feed or bioactive compounds. Sustainable exploitation of these non-conventional resources could provide new economic opportunities while diversifying national fishery production.

125. (A) I, II, and III
Turtle Excluder Devices are essential tools for reducing the incidental capture of marine turtles in shrimp trawl nets. They consist of a metal grid that allows smaller target species like shrimp to pass through into the codend while diverting larger objects like turtles through an escape flap. These devices are mandatory in many Indian states to meet conservation goals and international trade requirements, and their proper use significantly reduces turtle mortality without substantial loss of catch.

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126. (A) Maintaining the intra-specific genetic diversity of fish stocks.
Conservation of genetic resources in fisheries focuses on preserving the natural genetic variation within and between fish populations. This diversity is essential for the long-term resilience and adaptability of species to environmental changes and diseases. Management practices aim to prevent the loss of unique genetic lineages through overfishing, habitat destruction, or the introduction of non-native species. Maintaining genetic health ensures that fish stocks remain productive and capable of sustaining future generations.

127. (A) An underwater mountain rising from the ocean floor.
Seamounts are prominent topographic features of the ocean floor, often formed by volcanic activity. These underwater mountains rise significantly above the surrounding seabed but do not reach the surface. They interact with deep-ocean currents to create unique hydrological conditions, such as localized upwelling, which enhance primary productivity and attract diverse marine life. Seamounts are recognized as critical hotspots for biodiversity and often support specialized fisheries for both pelagic and demersal species.

128. (A) They induce upwelling and Taylors that retain plankton.
The physical presence of a seamount disrupts the flow of deep-ocean currents, creating complex hydrological features like Taylor columns or localized upwelling. These processes bring nutrient-rich water to the sunlit surface and trap plankton in the vicinity of the seamount. This concentration of food attracts various marine organisms, from small fishes to large predators, making seamounts highly productive areas that support significant concentrations of marine life and valuable commercial fisheries.

129. (C) Implementation of mesh size regulations
Aquatic biodiversity faces numerous threats, including habitat loss, pollution, and the introduction of invasive species. However, the implementation of mesh size regulations is a management tool designed to protect biodiversity by allowing juvenile fish to escape and survive. By ensuring that only larger, mature individuals are harvested, these regulations help maintain the reproductive capacity of populations and

support the overall health of the aquatic ecosystem, rather than acting as a threat.

130. (D) Growth overfishing
Growth overfishing occurs when fish are harvested at a size smaller than what would produce the maximum yield per recruit. This typically involves the capture of many juveniles before they have reached their full growth potential. While it may not immediately threaten the survival of the population, it represents an inefficient use of the resource and reduces the total potential catch. Management focuses on implementing size limits and mesh regulations to mitigate this issue.

131. (C) Vembanad Lake
Vembanad Lake is a major estuarine system in Kerala whose ecology is significantly influenced by the southwest monsoon and human interventions. The Thanneermukkom Bund was constructed to prevent saltwater intrusion into the southern part of the lake during the summer, allowing for freshwater agriculture. This structure has altered the salinity regime and impacted the migration and distribution of various aquatic species, including prawns and fishes, within this complex backwater ecosystem.

132. (B) The spatial and temporal gradients of salinity
Estuaries are characterized by the mixing of freshwater from rivers and saltwater from the sea, creating a dynamic environment with varying salinity levels. The distribution and diversity of species within an estuary are primarily determined by their ability to tolerate these fluctuations. Some organisms are adapted to low-salinity upper reaches, while others thrive in the more marine conditions near the mouth. These salinity gradients are fundamental to the ecological structure of estuarine fisheries.

133. (A) Sun-drying on bamboo scaffolds along the beaches
The Bombay Duck is unique for its high water content and soft texture, which requires specialized processing techniques. Traditionally, the fish is sun-dried on tall bamboo scaffolds along the coasts of Gujarat and Maharashtra. This method allows for efficient preservation and creates a distinct product that is highly valued in regional markets. The drying process is a vital component of the local economy and defines the traditional fishery associated with this species.

134. (B) Oreochromis mossambicus (Tilapia)
The introduction of exotic species can have significant negative impacts on native aquatic biodiversity and fisheries. In India, the Mozambique tilapia was introduced and has since become widespread in many inland water bodies. Due to its rapid reproduction and hardiness, it often outcompetes native fishes for food and habitat, leading to a decline in endemic species. Managing invasive exotics is a critical challenge for the conservation of natural riverine and lake fisheries.

135. (A) I, II, III, and IV
Marine crustaceans exhibit diverse reproductive strategies and life cycles. Penaeid shrimps broadcast their eggs into the water, while non-penaeids and many crabs carry them until they hatch. Some species, like mud crabs, migrate to the ocean to spawn, while others, like lobsters, have prolonged planktonic larval stages. All these groups possess a hard exoskeleton or carapace. Understanding these biological patterns is essential for the sustainable management of crustacean resources and their habitats.

136. (B) Sovereignty is absolute in territorial waters; the EEZ is for resources.
International maritime law distinguishes between several zones based on the level of state authority. Territorial waters extend to 12 nautical miles from the baseline, where the coastal state exercises full sovereignty, similar to its land territory. The Exclusive Economic Zone extends further to 200 nautical miles, where the state has specific sovereign rights for the exploration and exploitation of natural resources, rather than total sovereignty over all activities and international transit.

137. (A) High capital investment for vessels and specialized gear
Exploiting deep-sea resources requires advanced technology and significant financial investment compared to traditional coastal fishing. Specialized vessels equipped with powerful winches, deep-water trawls, and sophisticated navigation and sonar systems are necessary to operate at depths beyond 200 meters. These high costs, combined with the need for specialized knowledge and logistical support, act as a major constraint for the expansion of deep-sea fishing in many developing nations, including India.

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138. (A) Scads, Trevallies, and Pompanos
The family Carangidae comprises a diverse group of marine fishes that are significant components of both pelagic and demersal fisheries. Common members include scads, trevallies, pompanos, and jacks, which are found in a wide range of habitats from coastal reefs to the open ocean. These fishes are valued for their meat and are targeted by various gears, including lines, nets, and trawls. Their diversity and abundance make them ecologically and economically important resources.

139. (A) Beam trawl
A beam trawl is an active fishing gear designed to capture bottom-dwelling species by dragging a net across the seafloor. The mouth of the net is kept open by a rigid horizontal beam. Because it maintains constant contact with the seabed, it can cause significant physical disturbance to benthic habitats and result in high levels of bycatch. Understanding the impact of such bottom-contact gears is essential for implementing sustainable management and habitat protection measures.

140. (A) Both A and R are true and R is the correct explanation of A.
Tropical marine fisheries are inherently more complex than temperate systems because they involve hundreds of species with overlapping distributions and diverse life histories. Continuous spawning and recruitment patterns make traditional age-based assessments difficult. Furthermore, the widespread use of varied and often unselective fishing gears results in a multi-species catch that is hard to monitor and manage effectively. These challenges require specialized modeling approaches and robust data collection systems tailored to tropical ecosystems.

141. (A) Food and Agriculture Organization (FAO) of the United Nations
The Food and Agriculture Organization is the lead international agency responsible for the collection, analysis, and dissemination of global fishery and aquaculture data. It provides the standardized framework for reporting catch statistics and publishes periodic reports on the status of world fisheries. This information is vital for international policy-making, monitoring global food security, and promoting the sustainable management of aquatic resources across all nations and ocean basins.

142. (A) Western Indian Ocean
Major Marine Fishing Area 51 is the FAO designation for the Western Indian Ocean. This region includes the Arabian Sea and the waters off the coast of East Africa and the western coast of India. It is a highly productive area supported by significant upwelling systems and diverse marine habitats. Standardizing these zones allows for effective monitoring of catch data and the development of regional management strategies for shared fish stocks and ecosystems.

143. (B) ELEFAN (Electronic LEngth Frequency ANalysis)
In tropical fisheries, determining the age of fish from hard parts like otoliths can be challenging due to the lack of distinct seasonal growth rings. Instead, researchers often use length-frequency data and computer-based methods like ELEFAN to estimate growth and mortality parameters. This approach analyzes the progression of size modes in the population over time, providing a practical alternative for assessing the dynamics and sustainability of multi-species tropical fish stocks.

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144. (A) Intermittent heavy exploitation followed by recovery periods.
Pulse fishing is a management or exploitation strategy where intense fishing activity is allowed for a short period, followed by a closure to allow the stock to recover. This approach is sometimes used to exploit highly seasonal resources or to manage stocks with fluctuating abundance. However, it requires careful monitoring and control to prevent long-term depletion and ensure that the recovery periods are sufficient to maintain the population's overall reproductive capacity and health.

145. (A) Oil sardines and mackerel
Ring seines are a specialized type of encircling net used primarily in the coastal waters of Kerala to capture large schools of pelagic fishes. The main target species for this fishery are the Indian oil sardine and the Indian mackerel. This gear is highly efficient and has evolved from traditional shore seines to be operated from motorized or mechanized vessels, supporting a significant portion of the region's marine fish production and local livelihoods.

146. (D) Recreational fishing constitutes the largest volume of total fish landings in India.
Recreational and sport fishing in India is a growing sector that promotes conservation practices like catch-and-release and generates significant revenue through ecotourism, particularly for iconic species like the Golden Mahseer. However, it represents only a small fraction of the total fish landings compared to the massive volumes produced by commercial and artisanal capture fisheries. The primary contribution of recreational fishing is in its social, economic, and conservation impacts rather than in total biomass harvested.

147. (A) It decreases.
Marine species richness generally follows a latitudinal gradient, where the highest levels of biodiversity are found in tropical regions near the equator. As one moves toward higher latitudes and the polar regions, the number of different species typically decreases. This pattern is influenced by factors such as water temperature, productivity, and historical evolutionary processes. Understanding these global gradients is essential for prioritizing conservation efforts and managing biodiversity on a global scale across different oceanic regions.

148. (A) Swordfish (Xiphias gladius)
The swordfish is a large, highly migratory pelagic predator characterized by its extremely long, flattened bill and streamlined body. It is found in temperate and tropical waters worldwide and is a primary target for oceanic longline fisheries due to its high commercial value. As an apex predator, it plays a vital role in maintaining the balance of marine food webs. Management of swordfish stocks requires international cooperation to ensure their sustainable exploitation across vast oceanic ranges.

149. (B) The theoretical maximum length a fish would reach eventually
In the Von Bertalanffy Growth Equation, L_∞ represents the asymptotic length, which is the theoretical maximum size an individual in the population would reach if it lived for an infinite amount of time. This parameter is fundamental for modeling the growth rate of a species and is used to estimate other biological characteristics like mortality and yield. Accurate estimation of L_∞ is essential for the effective stock assessment and management of various fish populations.

150. (A) P-3, Q-2, R-1, S-4
Different fishing gears are designed to target specific species in various marine environments. Dol nets are stationary bag nets used for Bombay duck in tidal areas, while longlines are used for oceanic tunas and billfishes. Bottom trawls are the primary gear for demersal species and shrimp, and squid jigs are specialized tools for capturing cephalopods, often utilizing light for attraction. Understanding these gear-target relationships is fundamental to managing fisheries and reducing incidental impacts on the ecosystem.

151. (A) Epilimnion (photic zone)
In a stratified freshwater lake, the epilimnion is the uppermost layer where sunlight penetrates, allowing for photosynthesis by phytoplankton. This zone is typically warmer and well-oxygenated, making it the most productive part of the water column. It supports the majority of the lake's biological activity, from primary producers to the fish that feed on them. Management of lake fisheries focuses on maintaining the health and productivity of this sunlit layer to support sustainable harvests.

152. (A) Longitudinal spawning migrations of fishes
Many freshwater and anadromous fishes must migrate upstream to reach their specific spawning grounds. The construction of large dams acts as a physical barrier that prevents these movements, leading to a disruption of the life cycle and potential recruitment failure. This can result in a significant decline or local extinction of migratory species, such as the Hilsa shad or various carps. Mitigating these impacts requires the installation of effective fish passage structures and managed water flows.

153. (A) A coastal water body where freshwater mixes with seawater.
An estuary is a semi-enclosed coastal body of water where freshwater from rivers and streams meets and mixes with saltwater from the ocean. This interaction creates a unique environment with fluctuating salinity, high nutrient levels, and high biological productivity. Estuaries serve as critical nursery grounds for many marine species and support a wide variety of flora and fauna. They are among the most ecologically and economically important habitats on earth, requiring careful management and protection.

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154. (A) Anguilla spp. (Freshwater eels)
Catadromous migration is a life history strategy where fishes spend most of their adult lives in freshwater but migrate to the sea to spawn. Freshwater eels of the genus Anguilla are the most famous example, undertaking vast transoceanic journeys to reach their distant spawning grounds in the open ocean. Their larvae then drift back to coastal areas and enter river systems to grow. This complex life cycle makes them vulnerable to habitat fragmentation and changes in oceanic currents.

155. (A) Bathypelagic
The bathypelagic zone extends from depths of 1000 to 4000 meters and is characterized by a complete absence of solar light. The environment is extremely cold, under high hydrostatic pressure, and has low food availability. Organisms living in this zone have evolved specialized adaptations, such as bioluminescence, slow metabolisms, and unique body forms, to survive in these challenging conditions. This vast, dark layer of the ocean is one of the least explored and most mysterious habitats on our planet.

156. (A) Pole-and-line
Pole-and-line fishing is a traditional and highly selective method used primarily for catching tuna. It involves using a pole with a line and a barbless hook to pull fish from the water individually. This technique results in virtually no bycatch of non-target species like turtles or dolphins and causes no damage to the benthic habitat. Because of its low environmental impact and high selectivity, pole-and-line is considered one of the most sustainable fishing methods globally.

157. (A) Threadfin breams (Nemipterus spp.)
Threadfin breams are a significant demersal resource in India and are the primary raw material for the production of surimi. Surimi is a stabilized, minced fish protein used to create various imitation seafood products. The demand for these fishes in the export market has led to the development of a lucrative specialized fishery. Effective management is needed to ensure that the harvest of threadfin breams remains sustainable and does not negatively impact the broader marine ecosystem.

158. (A) Antarctic krill - Fish meal and omega-3 oil extraction
Antarctic krill is a vast, underutilized marine resource with significant potential for industrial applications. It is rich in protein and omega-3 fatty acids, making it a valuable raw material for the production of high-quality fishmeal and nutritional supplements. Although it is a foundational species in the Southern Ocean food web, carefully managed exploitation can provide economic benefits while ensuring that the needs of marine predators are met through robust international regulations and precautionary catch limits.

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159. (A) Giant Triton (Charonia tritonis)
The Giant Triton is a large predatory sea snail that plays a critical role in maintaining the health of coral reef ecosystems. It is one of the few natural predators of the Crown-of-Thorns starfish, which can cause extensive damage to corals when its population grows out of control. By preying on these starfish, the triton snail helps prevent reef destruction and supports the balance of the marine community. Protecting these snails is an important part of coral reef conservation efforts.

160. (A) Using square mesh panels
Square mesh panels are technical modifications integrated into trawl nets to improve size selectivity. Unlike traditional diamond meshes, which tend to close when under tension during towing, square meshes remain open. This allows smaller, undersized fish to escape the net while it is still in the water, reducing bycatch and protecting juveniles. Implementing these modifications is an effective way to promote more sustainable fishing practices and ensure the long-term health of commercially targeted fish populations.

161. (A) Global cooperation for conservation and management.
Article 64 of the United Nations Convention on the Law of the Sea addresses the management of highly migratory species, such as tunas and billfishes. It mandates that coastal states and other nations whose vessels fish for these species must cooperate directly or through international organizations to ensure their conservation. This recognition of the need for collaborative management is essential for protecting species that move across multiple national and

international jurisdictions throughout their life cycles.

162. (A) Solenocera choprai
Solenocera choprai is a species of deep-sea shrimp that is a significant target for specialized trawling operations along India's continental slope. Found at depths beyond 200 meters, these crustaceans require advanced gear and vessels for their exploitation. They are commercially valuable and represent an important component of the deep-water fishery. Sustainable management of these deep-sea resources is critical, as they may have slower growth rates and be more sensitive to fishing pressure than shallow-water species.

163. (A) Pole-and-line fishing for Skipjack Tuna using live bait.
The fisheries of the Lakshadweep Islands are distinct from the mainland because of their focus on oceanic tunas, particularly skipjack. The traditional pole-and-line method uses live bait collected from the lagoons to attract and capture tuna from the surrounding open waters. this highly selective and sustainable technique is a vital part of the islands' economy and culture. Protecting the baitfish resources and managing the tuna harvest is essential for the long-term viability of this unique fishery.

164. (A) Late maturity, low fecundity, and long lifespan.
K-selected species are characterized by life history traits that favor survival in stable environments. These organisms, including many sharks and marine mammals, typically grow slowly, reach sexual maturity at a late age, and produce only a few offspring. These traits make them highly vulnerable to overexploitation, as their populations cannot recover quickly from high mortality. Conservation of K-selected species requires cautious management and protection of their breeding and nursery habitats to ensure their long-term survival.

165. (A) Relationship between spawning stock and future recruits.
The stock-recruitment relationship is a fundamental concept in fisheries science that describes how the number of new young fish entering a fishery depends on the size of the adult breeding population. Understanding this relationship is critical for determining the sustainable harvest level and preventing recruitment overfishing. While environmental factors also play a role, maintaining a sufficient spawning stock biomass is essential for ensuring that the population can replenish itself and support continued fishing over the long term.

166. (A) Ricker model
The Ricker model is a mathematical representation of the stock-recruitment relationship that assumes recruitment will decrease at very high levels of spawning biomass. This decline is attributed to density-dependent factors such as cannibalism of eggs and larvae by adults or competition for limited resources. This model is often applied to species where these interactions are prominent, and it helps fishery managers understand the potential for self-regulation within a population and set appropriate harvest targets.

167. (A) It prevents other nations from laying submarine cables.
The Exclusive Economic Zone grants coastal nations sovereign rights over the exploration and exploitation of natural resources within 200 nautical miles of their baseline. This includes rights over the seabed, subsoil, and water column. However, under international law, other nations still retain the right to lay submarine cables and pipelines within a state's EEZ. Understanding these rights and responsibilities is essential for managing international maritime relations and protecting the marine environment and its resources.

168. (A) Protecting breeding populations to allow recruitment.
Closed seasons, such as the monsoon fishing ban in India, are implemented to protect fish populations during their critical spawning periods. By preventing fishing activity when many species are breeding, these measures help ensure that sufficient numbers of offspring are produced to replenish the stock. This leads to better recruitment and supports the long-term sustainability of the fishery. Protecting the breeding cycle is a key component of effective resource management and helps maintain the health of the entire ecosystem.

169. (A) Small-scale fisheries with low capital and simple gears.
Artisanal fisheries are typically small-scale operations that utilize traditional knowledge and simple gears such as lines, small nets, and

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traps. They often involve non-mechanized or small motorized boats and are deeply integrated into the local culture and economy of coastal communities. These fisheries provide essential food and livelihoods for millions of people and generally have a lower environmental impact than industrial operations. Supporting and managing artisanal sectors is critical for achieving social and economic sustainability.

170. (A) The upper layer where light allows for photosynthesis.
The photic zone is the uppermost layer of an aquatic body that receives enough sunlight to support the process of photosynthesis. This zone is the most productive part of the ocean or lake, as it is where phytoplankton, the primary producers, can grow and multiply. It forms the foundation of the aquatic food web, supporting a diverse range of organisms from microscopic grazers to large fish and predators. The depth of the photic zone depends on water clarity.

171. (A) Octopus
Octopuses are known for their habit of seeking shelter in crevices and small enclosures for protection. This behavior is exploited in specialized fisheries that use pots, jars, or traps to capture them. These gears are often unbaited and provide an artificial habitat that attracts the octopus. This method is highly selective and has a low environmental impact, making it a sustainable way to harvest these valuable cephalopods while minimizing the incidental catch of other marine species.

172. (A) Specific species a gear is designed and deployed to catch.
Target catch refers to the particular species or group of species that a fisherman intends to capture when deploying their gear. Fishing equipment and techniques are often tailored to the biological and behavioral characteristics of the target, such as its size, habitat, and feeding habits. In managed fisheries, the target catch is the primary focus of stock assessments and catch limits. Minimizing the capture of non-target species, or bycatch, is a key goal for achieving sustainable and responsible fishing.

173. (A) Eutrophication leading to algal blooms and fish kills.
The excessive runoff of fertilizers from agricultural land into lakes leads to a condition called eutrophication, where high nutrient levels stimulate rapid algal growth. These blooms can block sunlight and deplete dissolved oxygen when the algae die and decompose. This lack of oxygen can cause mass mortality of fish and other aquatic organisms, creating a dead zone within the lake. Managing nutrient inputs is essential for protecting the health and productivity of natural lake ecosystems and their fisheries.

174. (A) International Union for Conservation of Nature
The International Union for Conservation of Nature is a global organization dedicated to the conservation of nature and the sustainable use of natural resources. It is best known for the IUCN Red List of Threatened Species, which provides a comprehensive assessment of the extinction risk of thousands of taxa, including many marine and freshwater fishes. The IUCN's work is fundamental for setting conservation priorities and informing international agreements and national policies for the protection of biodiversity worldwide.

175. (A) The Sundarbans (Hooghly-Matlah system)
The Sundarbans is a massive mangrove forest and estuarine delta system that supports a rich and diverse fishery. It is a critical habitat for various species, including the commercially valuable mud crab and several types of penaeid shrimps. The complex network of tidal channels and mangroves provides essential nursery grounds and nutrient-rich environments for these organisms. Protecting this unique ecosystem is vital for the sustainability of local fisheries and the conservation of many endangered species that inhabit the region.

176. (A) Presence of photophores for bioluminescence.
Deep-sea fishes like myctophids inhabit the mesopelagic zone, where light is very faint. Many of these species have evolved specialized organs called photophores that produce light through bioluminescence. This adaptation is used for communication, attracting prey, and camouflage through counter-illumination, which helps them blend in with the faint light from above to avoid predators. These unique biological features are essential for survival in the twilight zone and are a characteristic trait of many organisms living at significant oceanic depths.

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177. (A) Trawling hours multiplied by the engine horsepower.
In a trawl fishery, fishing effort is a measure of the total amount of fishing activity applied to the stock. A more accurate measure of this effort accounts for both the time spent fishing and the capacity of the vessel, such as its engine horsepower. By multiplying trawling hours by horsepower, researchers can better represent the actual pressure exerted on the resource. This refined metric helps in more precise stock assessments and in understanding the relationship between effort and fish abundance over time.

178. (A) The Low Water Line on official nautical charts.
The baseline is the starting point for measuring the various maritime zones of a coastal state, including the territorial sea and the Exclusive Economic Zone. According to international law, the normal baseline is the low-water line along the coast as marked on large-scale nautical charts. In some cases, straight baselines may be used for deeply indented coasts. Accurately defining the baseline is essential for establishing a nation's maritime boundaries and exercising its sovereign rights over its marine resources.

179. (A) Hypoxia (Dead zones) - Mortality of benthic fauna.
Hypoxia refers to a condition where dissolved oxygen levels in the water are so low that most aquatic organisms cannot survive. This often occurs in bottom waters due to eutrophication and stratification, leading to the formation of dead zones. Benthic fauna, which are often sedentary or slow-moving, are particularly vulnerable to these events, resulting in high mortality and the disruption of the seafloor ecosystem. Managing nutrient runoff and monitoring oxygen levels is critical for preventing these catastrophic impacts on marine life.

180. (A) Pole-and-line
Pole-and-line fishing is an environmentally responsible method for catching pelagic species like tuna. It utilizes a single hook and line for each fish, ensuring high selectivity and virtually no incidental catch of non-target animals like turtles or dolphins. Additionally, because the gear does not come into contact with the seafloor, it causes no damage to sensitive benthic habitats. This sustainable approach is increasingly favored in the global market and is an important part of responsible fishery management in oceanic regions.

181. (A) Fishing that alters the functioning of the marine ecosystem.
Ecosystem overfishing occurs when the cumulative impact of fishing pressure results in significant changes to the overall structure and health of the marine community. This can include the removal of key predators, the depletion of foundational species, or alterations in the food web that lead to reduced resilience and biodiversity. Unlike single-species overfishing, this concept considers the broader ecological interactions and aims to manage fisheries in a way that preserves the integrity and functioning of the entire ecosystem.

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182. (A) Red seaweeds (e.g., Gelidium, Gracilaria)
Red seaweeds are the primary source of agar, a valuable phycocolloid used in a wide range of laboratory and food applications. Genera such as Gelidium and Gracilaria are harvested or cultivated globally to extract this high-value product. The production of agar is a significant industry that supports livelihoods in many coastal regions. Sustainable management and cultivation of these seaweeds are important for meeting growing demand while protecting the natural marine environment and its diverse biological resources.

183. (A) They carry fertilized eggs on pleopods until hatching.
Penaeid shrimps are distinguished from other shrimp groups by their reproductive strategy, as they broadcast their eggs directly into the water column rather than carrying them. Their life cycle is complex, involving offshore spawning in deep marine waters and a migration of post-larvae into nutrient-rich coastal estuaries and backwaters to grow. This dependence on both marine and estuarine habitats makes them vulnerable to environmental changes and habitat loss in both environments. Understanding this life cycle is essential for their management.

184. (A) The bag-like section where the catch accumulates.
The codend is the narrow, rear-most part of a trawl net where the captured fish and other organisms are collected during the towing process. It is the part of the gear that determines the size selectivity of the catch, as the mesh size in the

codend allows smaller individuals to escape while retaining larger ones. Technical modifications to the codend, such as using square mesh or larger diamond mesh, are important tools for reducing bycatch and protecting juvenile fish in commercial trawling operations.

185. (A) The upper reaches of the Himalayan rivers
The upper reaches of Himalayan rivers provide a specialized coldwater habitat characterized by fast-flowing, oxygenated water and rocky substrates. These conditions are ideal for the Snow trout (Schizothorax spp.), which has evolved unique morphological adaptations to thrive in such torrential environments. These rivers are critical for the survival of many endemic species and support important local and recreational fisheries. Protecting these pristine habitats from pollution and fragmentation is essential for the conservation of mountain aquatic biodiversity.

186. (A) Slow growth and late maturity make recovery very slow.
Many deep-sea species possess life history traits that make them exceptionally vulnerable to fishing pressure. These fishes often grow very slowly, reach sexual maturity at a late age, and have low natural mortality rates. Consequently, once a population is depleted, it may take decades or even centuries for it to recover. Managing deep-sea fisheries requires a highly precautionary approach, including strict catch limits and the protection of sensitive habitats, to avoid the permanent collapse of these fragile and slow-growing resources.

187. (A) Shape and orientation of the mouth and lips.
Taxonomists use several physical characteristics to distinguish between different species of Indian Major Carps. One of the most important features is the position and shape of the mouth and lips, which reflects the feeding habits of each species. For example, Catla has a large, upturned mouth for surface feeding, while Rohu has a terminal mouth for mid-water feeding. These morphological differences are essential for accurate identification and for understanding the ecological roles of these significant freshwater fish resources.

188. (A) Kerala
Kerala is historically known as a major hub for pelagic fisheries in India, particularly for the Indian oil sardine and Indian mackerel. The state's coast experiences intense seasonal upwelling, which drives high primary productivity and supports massive schools of these small pelagics. This abundance has led to the development of a diverse and productive fishing sector that is vital for the state's economy and the food security of its population. Sustainable management of these fluctuating resources is a key priority for the region.

189. (A) Monsoon freshwater runoff and lunar tidal cycles.
The salinity of Indian estuaries fluctuates significantly due to the interplay between seasonal freshwater inflow and the regular movement of seawater. During the monsoon, heavy rainfall and river discharge lead to a drop in salinity, sometimes making the system almost freshwater. Conversely, during the dry season, tidal influx from the ocean increases salinity levels. These dynamic changes define the estuarine environment and influence the migration and distribution of the many aquatic species that are adapted to such varying conditions.

190. (D) Both A and R are false.
While Bycatch Reduction Devices are essential for sustainable fishing, they have not been universally adopted without resistance, as some fishers fear they may lead to a loss of target catch. Furthermore, BRDs are designed to decrease, not increase, the total retained catch by allowing non-target species and juveniles to escape. Therefore, the assertion that they are accepted without resistance and the reason that they increase economic revenue are both incorrect based on the practical realities of fishery management and gear technology.

191. (A) Catch and Effort data over several years.
Surplus production models, such as the Schaefer model, are used to estimate the maximum sustainable yield of a fishery based on historical records of catch and fishing effort. These models treat the entire stock as a single biomass and assume that the population's growth is related to its current density. By analyzing how catch rates change with different levels of effort over many years, scientists can determine the level of harvest that will allow the stock to remain productive over the long term.

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192. (A) Top-down control (Trophic cascade)
A trophic cascade occurs when the removal or addition of a top predator leads to a series of reciprocal changes in the populations of lower trophic levels. For example, overfishing of sharks can lead to an increase in the number of smaller predatory fishes, which then overgraze on herbivores, potentially allowing algae to flourish and smother coral reefs. This top-down control illustrates the complex interconnections within marine food webs and the potential for wide-reaching ecological consequences when apex predators are depleted.

193. (A) Large mechanized commercial trawlers
Most coastal states in India have regulations that restrict large mechanized commercial vessels, such as trawlers, from operating in the shallow waters of the territorial sea. This is done to protect the livelihoods of traditional and small-scale fishers who depend on these nearshore areas and to safeguard sensitive coastal nursery habitats. By creating designated zones for different sectors, management aim to reduce conflict and ensure that fishing pressure is distributed in a way that supports both ecological and social sustainability.

194. (A) Organisms living on or near the aquatic bottom.
Benthos refers to the diverse community of organisms that inhabit the seafloor or the bottom of freshwater bodies. This group includes a wide range of species, from microscopic bacteria and worms to larger crustaceans, mollusks, and bottom-dwelling fishes. Benthic organisms play essential roles in nutrient cycling and energy transfer within the aquatic ecosystem. They are also important indicators of environmental health and serve as a primary food source for many commercially valuable demersal and pelagic species.

195. (A) Water level drawdown disrupts spawning grounds.
In reservoir fisheries, the management of water levels for irrigation and power generation can have significant ecological consequences. A rapid drawdown can expose the shallow areas that many fish species use as spawning and nursery grounds, leading to the loss of eggs and larvae. This disruption of the reproductive cycle can cause a decline in fish populations and overall fishery productivity. Effective management requires balancing the competing needs for water with the conservation of the aquatic habitat and its biological resources.

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196. (A) Marine areas not included in any State's EEZ.
The high seas are the parts of the ocean that lie beyond the national jurisdiction of any coastal state, typically starting 200 nautical miles from the baseline. According to international law, these waters are open to all nations for peaceful activities such as navigation, overflight, and fishing. However, managing resources in the high seas is challenging and requires international cooperation and agreements to ensure that activities like deep-sea fishing and mining are conducted sustainably and do not harm global marine biodiversity.

197. (A) Diatoms (Phytoplankton)
Phytoplankton, including diatoms, are the primary producers of the open ocean ecosystem. Using sunlight and nutrients, they perform photosynthesis to create organic matter, forming the foundation of the marine food web. They are responsible for a large portion of the world's oxygen production and play a critical role in global carbon cycling. All higher trophic levels, from tiny zooplankton to massive whales and commercial fish stocks, ultimately depend on the energy produced by these microscopic plants in the sunlit layers of the ocean.

198. (A) Butterflyfishes (Chaetodontidae)
Indicator species are organisms whose presence, absence, or abundance reflects the health and condition of their environment. In coral reef ecosystems, butterflyfishes are often used as indicators because many species feed exclusively on coral polyps. A decline in their population can signal a decline in coral health or diversity due to stressors like pollution or bleaching. Monitoring these fishes provides scientists and managers with valuable information about the overall status and resilience of the reef and helps guide conservation efforts for these sensitive habitats.

199. (A) Spatial zones where fishing is restricted for conservation.
Marine Protected Areas are designated regions of the ocean where human activities, particularly fishing, are restricted or managed to achieve specific conservation goals. These areas can range from no-take zones, where all

fishing is prohibited, to multiple-use areas that allow for sustainable exploitation. MPAs help protect biodiversity, preserve critical habitats, and provide refuges for depleted fish stocks to recover. By maintaining the health of the marine ecosystem, they also support the long-term productivity and resilience of the fisheries in the surrounding waters.

200. (A) P-4, Q-3, R-2, S-1
Fishery science utilizes specific terminology to describe the different aspects of resource exploitation and population biology. Discards are the portion of the catch returned to the sea, while effort is a measure of the total fishing activity applied. Yield refers to the total weight or number of fish that are legally landed and used. Fecundity is the measure of the reproductive capacity of an individual, often expressed as the number of eggs produced. Accurate use of these terms is essential for stock assessment and management.

201. (A) Zooplankton
Zooplankton are small, often microscopic animals that drift in the water column and feed on phytoplankton. They serve as the critical intermediate link in the marine food web, transferring energy from primary producers to larger consumers, including many commercially important pelagic fishes. By grazing on the vast blooms of phytoplankton, zooplankton convert plant biomass into animal tissue that can be utilized by higher trophic levels. Their abundance and diversity are key factors influencing the overall productivity and health of the marine ecosystem.

202. (A) Lunate caudal fin and streamlined fusiform body.
Pelagic fishes that swim continuously in the open ocean, such as tuna, have evolved specialized morphological features for high-speed and efficient movement. A streamlined, fusiform body shape reduces drag, while a lunate (crescent-shaped) caudal fin provides powerful propulsion with minimal effort. These adaptations allow these predators to travel vast distances and successfully capture fast-moving prey. Understanding these physical traits is essential for studying the ecology and behavior of migratory species and for developing effective fishing and management strategies for oceanic resources.

203. (A) It spawns only once in its life (semelparity).
The Indian oil sardine is a fast-growing, short-lived pelagic fish that attains sexual maturity within its first year. Unlike semelparous species that die after spawning once, the sardine is iteroparous and can spawn multiple times during its lifespan. Its spawning season is closely linked to environmental cues, particularly the onset of the southwest monsoon, which drives productivity in coastal waters. Understanding its reproductive biology and life history is essential for managing this highly fluctuating and commercially important resource in the Indian Ocean.

204. (A) Counting growth rings on hard structures like otoliths.
Determining the age of fish is fundamental for understanding their growth, mortality, and population dynamics. In many temperate and some tropical species, hard structures like otoliths (ear stones) develop annual growth rings, similar to the rings in a tree. By counting these rings, scientists can accurately estimate the age of individual fish. This information is essential for building age-structured stock assessment models and for setting appropriate harvest limits to ensure the long-term sustainability of the fishery and the health of the fish population.

205. (A) Natural Mortality (M)
Natural mortality represents the rate at which individuals are removed from a fish population due to all causes other than fishing. This includes predation, disease, competition, and senescence. Estimating natural mortality is critical for stock assessments, as it helps determine the underlying productivity of the population and how much fishing pressure it can sustainably withstand. Although difficult to measure directly, it is often estimated from life history traits like growth rate and maximum age, providing a vital baseline for fishery management decisions and modeling.

206. (A) Chilka Lake
Chilka Lake, located in Odisha, is recognized as Asia's largest brackish water lagoon. It is a highly productive ecosystem that supports a massive fishery, particularly for prawns, crabs, and various estuarine finfishes. The lake's connection to the Bay of Bengal and its influx of freshwater from several rivers create a dynamic salinity gradient that provides essential habitat for a wide range of species. It is also an important

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wintering ground for migratory birds, making it a globally significant site for biodiversity and local livelihoods.

207. (A) Catla catla
Catla catla is one of the most important species of Indian Major Carps used in aquaculture and inland fisheries. It is characterized by its broad head and a large, upturned mouth, which is a specialized adaptation for surface feeding. Its diet consists primarily of zooplankton filtered from the upper layers of the water column. Due to its rapid growth and high consumer preference, it is a key component of polyculture systems in ponds and is widely stocked in reservoirs across the Indian subcontinent to enhance production.

208. (A) Cyanide poisoning
Cyanide poisoning is a highly destructive fishing method used to capture live ornamental fish from coral reefs. The chemical is squirted into reef crevices to stun the fish, making them easy to catch. However, cyanide is a potent toxin that also kills coral polyps and other reef-associated organisms, leading to the long-term degradation and bleaching of the reef habitat. This illegal practice causes irreversible damage to marine biodiversity and the structural integrity of the reef, threatening the sustainability of the very resources it targets.

209. (A) Detection of water movement and pressure gradients.
The lateral line system is a specialized sensory organ found in fishes that allows them to detect vibrations, water movement, and pressure changes in their environment. This system consists of a series of fluid-filled canals and sensory cells located along the sides of the fish's body. It is essential for various behaviors, including schooling, navigating in dark or murky waters, and detecting the movement of both prey and predators. This unique adaptation provides fishes with a sophisticated way to perceive their surroundings and respond to physical changes.

210. (A) Lobsters and Crabs
Pots and traps are specialized, passive fishing gears designed to capture bottom-dwelling crustaceans like lobsters and crabs. These gears are typically baited with trash fish to attract the target species into an enclosure from which they cannot easily escape. This method is highly selective and has a low environmental impact on the surrounding habitat compared to active gears like trawls. Managing these fisheries involves regulating the number of traps, their design, and the size of the catch to ensure the sustainability of these high-value marine resources.

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211. (A) The Coral Triangle (Indo-Pacific)
The Coral Triangle is a marine region in the western Pacific Ocean that is recognized as the global epicenter of marine biodiversity. It contains a higher concentration of coral and reef fish species than anywhere else on earth. This area is essential for the health of global oceans and provides food and livelihoods for millions of people. Protecting the Coral Triangle from threats like climate change, overfishing, and pollution is a major priority for international conservation efforts aimed at preserving the world's most diverse marine ecosystems and resources.

212. (A) The Allometric Growth Equation
The relationship between the length and weight of a fish is typically described by the allometric growth equation. This mathematical model relates weight to the cube of the length, with parameters that vary between species and populations. Understanding this relationship is essential for converting length data from field surveys into biomass estimates, which are critical for stock assessments. It also provides insights into the condition and growth patterns of the fish, helping scientists and managers evaluate the health and productivity of the population under different environmental and fishing pressures.

213. (A) Longline - Using sonic pulses to stun fish.
Different fishing gears use specific physical or behavioral mechanisms to capture their target species. Gillnets rely on the fish becoming gilled or entangled in the mesh, while purse seines surround pelagic schools. Bottom trawls are actively towed to scoop up bottom-dwelling organisms. However, longlines use baited hooks on a long main line to capture fish, not sonic pulses. Accurate understanding of gear mechanisms is essential for managing their selectivity and environmental impact and for developing responsible fishing practices that minimize bycatch and habitat damage.

214. (A) An intense, intermediate Oxygen Minimum Zone (OMZ).
The Arabian Sea is characterized by a prominent Oxygen Minimum Zone at intermediate depths, where dissolved oxygen levels are extremely low. This phenomenon is caused by high primary productivity at the surface and the subsequent decomposition of organic matter in the deeper layers. The OMZ acts as a biological barrier, restricting the vertical and horizontal distribution of many commercial finfish species to the more oxygenated surface waters. This oceanographic feature has significant implications for the productivity and management of fisheries in the region and must be accounted for in stock assessments.

215. (A) Effort lower than MSY, maximizing profit margins.
Maximum Economic Yield is a bioeconomic concept representing the level of fishing effort that generates the greatest net profit from a fishery. This point is always located at a lower level of effort than the Maximum Sustainable Yield. By fishing slightly less than the biological maximum, the costs of operation are reduced more than the total revenue, resulting in a higher economic rent. Achieving MEY is a goal for management frameworks that prioritize the financial stability and long-term viability of the fishing industry alongside biological sustainability and resource conservation.

216. (A) Shallow estuary separated by sandbars or barrier islands.
A bar-built estuary is a shallow coastal water body that is partially enclosed by sandbars, barrier islands, or spits. These features are formed by the accumulation of sediment from longshore currents and riverine discharge. These estuaries often have limited exchange with the open ocean and are characterized by fluctuating salinity and high productivity. They provide critical habitats for many aquatic species and are important areas for coastal fisheries. Protecting these systems from pollution and habitat alteration is essential for maintaining their ecological health and the resources they support.

217. (A) Biomass estimated before commercial exploitation began.
Virgin biomass represents the total weight of a fish population before it has been subjected to any fishing pressure. It is a theoretical baseline used in fisheries science to evaluate the impact of exploitation on a stock. By comparing the current biomass to the estimated virgin biomass, scientists can determine the degree of depletion and set appropriate management targets to ensure recovery or sustainability. Estimating B_0 requires historical data or mathematical models that simulate the population's dynamics under natural conditions, providing a vital reference for resource management and conservation.

218. (A) UN Convention on the Law of the Sea (UNCLOS)
The 1982 United Nations Convention on the Law of the Sea is the comprehensive international agreement that established the legal framework for all activities in the world's oceans. A key provision of UNCLOS was the formal creation of the 200-nautical-mile Exclusive Economic Zone, granting coastal states sovereign rights over all natural resources within this area. This landmark treaty has defined national maritime boundaries, regulated international shipping and fishing, and provided the basis for the cooperative management and conservation of global marine biodiversity and habitats for the future.

219. (A) Intrinsic rate of population growth (r)
The intrinsic rate of population growth is a biological parameter that represents the maximum potential for a stock to increase in size when resources are abundant and mortality is low. Species with a high growth rate are generally more resilient and can recover more quickly from heavy fishing pressure compared to slow-growing species. Understanding this rate is essential for assessing the vulnerability of different fish populations and for setting sustainable harvest limits that allow the stock to replenish itself. It is a key component of mathematical models used in fishery stock assessments.

220. (A) Scombridae
The family Scombridae includes some of the most commercially and ecologically important pelagic fishes in the world, most notably the tunas and mackerels. These fishes are characterized by their streamlined bodies and powerful swimming abilities, allowing them to undertake vast migrations across ocean basins. They are targeted by diverse fishing fleets using gears such as longlines, purse seines, and pole-and-line. Due to their highly migratory nature, the management of scombrid stocks requires

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intensive international cooperation and scientific research to ensure that exploitation remains sustainable and that these vital marine resources are protected.

221. (A) High nutrient inputs from riverine runoff and tidal recycling
Estuaries are among the most productive ecosystems on earth because they receive a constant supply of nutrients from both freshwater and marine sources. Riverine runoff brings minerals and organic matter from the land, while tidal movements help to recycle nutrients and maintain their availability in the water column. This high nutrient loading stimulates the growth of phytoplankton and other primary producers, which in turn supports a diverse and abundant community of fish and invertebrates. Managing nutrient levels is essential for protecting the health and productivity of these critical coastal habitats and their fisheries.

222. (A) Tor malabaricus (Malabar Mahseer)
The Malabar Mahseer is a specialized freshwater fish endemic to the hill streams of the Western Ghats in India. It is a large cyprinid that is currently listed as endangered due to habitat loss, pollution, and the impact of dams on its native range. These fishes are significant indicators of the health of mountain river systems and are important for local and recreational fisheries. Protecting their remaining habitats and ensuring river connectivity is critical for the conservation of this unique and threatened species and the overall biodiversity of the Western Ghats region.

223. (A) Tragedy of the Commons via unowned resources.
In open-access fisheries, the lack of defined property rights or individual harvest limits can lead to a situation known as the tragedy of the commons. Because the resource is unowned, individual fishers have an incentive to harvest as much as possible before others do, leading to excessive effort and overexploitation of the stock. This often results in the depletion of the fish population and the dissipation of economic rent. Sustainable management aims to address this issue by implementing regulations such as quotas, licenses, and territorial rights to ensure that the resource is shared and used responsibly.

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224. (A) Whether the gear is towed or remains stationary.
Fishing gears are classified as either active or passive based on their operational mechanism. Active gears, such as trawls and purse seines, are moved through the water by a vessel to actively capture or surround the target species. In contrast, passive gears, such as gillnets, traps, and longlines, remain stationary and depend on the movement of the fish into the gear for capture. This distinction is important for managing the environmental impact and selectivity of fishing operations and for understanding the energy requirements and catch efficiency of different fishing sectors and techniques.

225. (A) Demersal longlining or trap fishing
Bottom trawling is known for its potential to damage sensitive benthic habitats and generate high levels of bycatch. Environmentally responsible alternatives for harvesting demersal species include the use of longlines or traps. These passive gears are set on the seafloor and have a much smaller physical footprint, causing minimal disturbance to the substrate and structural components like corals. They are also more selective and allow for the release of non-target species. Promoting the use of such gears is an important strategy for achieving more sustainable and ecosystem-based management of marine resources.

226. (A) High influx of nutrient-rich freshwater from major basins.
The Hooghly-Matlah estuarine system in the Ganga delta is highly productive due to the massive volume of nutrient-rich freshwater it receives from a large drainage basin. This influx provides the minerals and organic matter needed to support high rates of primary and secondary production. The system's complex network of tidal channels and adjacent mangroves further enhances its role as a nursery and feeding ground for many commercially important fish and shrimp species. Maintaining the quality and quantity of freshwater inflow is essential for the continued health and productivity of this vital estuarine fishery.

227. (A) MPAs are highly ineffective for restoring depleted stocks.
Marine Protected Areas are recognized as highly effective tools for biodiversity conservation and the restoration of depleted fish stocks.

By providing a refuge from fishing pressure, MPAs allow populations to grow, mature, and reproduce, leading to an increase in biomass and the potential for spillover into adjacent waters. While overexploitation and habitat destruction are major threats, the implementation of MPAs, alongside frameworks like the IUCN Red List, provides a critical pathway for protecting marine life and ensuring the long-term health and productivity of global oceanic and coastal ecosystems for future generations.

228. (A) Deep-sea hydrothermal vent communities
While most life on earth depends on photosynthesis driven by solar energy, certain ecosystems in the deep sea rely on chemosynthesis. At hydrothermal vents, specialized bacteria use chemical energy from sulfur and other minerals to produce organic matter. These bacteria form the base of a unique food web that supports diverse communities of tubeworms, crustaceans, and fishes in the dark, high-pressure environment of the deep ocean. These extraordinary ecosystems are hotspots of biodiversity and demonstrate the remarkable adaptability of life to extreme conditions, operating completely independently of sunlight and terrestrial inputs.

229. (A) A group of fish born during the same spawning season.
In fisheries population dynamics, a cohort represents a group of individuals of the same species that were born or recruited into the population during a specific time interval, usually a single spawning season. By tracking the growth, mortality, and catch of a cohort over several years, scientists can build age-structured models to assess the health and productivity of the stock. This approach, known as cohort analysis or virtual population analysis, is essential for determining how different levels of fishing pressure affect the abundance and age structure of a fish population over its entire lifespan.

230. (A) Excessive harvesting of the mature breeding stock.
Recruitment failure occurs when the number of young fish entering a fishery is significantly lower than needed to maintain the population. A primary cause of this is the excessive removal of the mature individuals that make up the spawning stock. If the breeding population is reduced below a certain threshold, it can no longer produce enough offspring to replenish the stock, even under favorable environmental conditions. Preventing recruitment failure is a fundamental goal of fishery management, achieved through measures such as catch limits, size regulations, and the protection of critical spawning and nursery habitats.

231. (A) FAO
The Code of Conduct for Responsible Fisheries was formally adopted by the Food and Agriculture Organization in 1995. This landmark international agreement provides a set of principles and standards for the sustainable management and conservation of all fisheries and aquaculture activities. It addresses issues such as resource exploitation, habitat protection, biodiversity conservation, and the social and economic well-being of fishing communities. While voluntary, the CCRF is widely recognized as the global framework for achieving responsible and sustainable aquatic resource management and has influenced national policies and international agreements worldwide.

232. (A) Sensory barbels located near the mouth.
Many benthic-feeding fishes, such as goatfishes and various catfishes, have evolved specialized organs called barbels to help them locate prey in the sediment. These whisker-like structures are equipped with taste and touch receptors, allowing the fish to detect hidden organisms like worms and small crustaceans in murky or dark waters. By scanning the seafloor with their barbels, these fishes can efficiently find food in environments where vision may be limited. This morphological adaptation is a characteristic feature of many bottom-dwelling species and reflects their specialized ecological niche and feeding behavior in diverse aquatic systems.

233. (A) Severe physical disturbance to the benthic substrate.
Bottom dredging is a fishing method that involves dragging a heavy metal frame and net along the seafloor to collect species such as scallops and oysters. This practice causes significant physical damage to the benthic habitat by shattering corals, crushing organisms, and churning up the sediment. The resulting loss of structural complexity and the suspension of sediment can have long-lasting negative impacts on the health and biodiversity of the seafloor ecosystem. Because of its high environmental

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impact, dredging is often strictly regulated or banned in sensitive areas to protect critical benthic communities and resources.

234. (A) Total Allowable Catch (TAC)
Total Allowable Catch is a management tool that sets a strict limit on the total volume of a particular fish species that can be harvested from a stock during a given year. This limit is based on scientific assessments of the stock's status and its ability to replenish itself. Once the TAC is reached, the fishery for that species is closed. TACs are often used in combination with other measures like quotas to ensure that the total harvest remains within sustainable levels and that the long-term health of the resource is protected for the future.

235. (A) Marine prawns/shrimps
The family Penaeidae includes many of the world's most commercially important marine prawns and shrimps. These crustaceans are found in a wide range of habitats, from shallow coastal estuaries to the deep waters of the continental shelf. They are highly valued for their meat and are a primary target for both industrial and artisanal fisheries and for extensive aquaculture operations. Penaeid shrimps have a complex life cycle and are significant components of marine food webs. Their abundance and high market demand make them economically vital resources for many coastal nations, requiring careful management to ensure sustainability.

236. (A) Thermocline
The thermocline is a vertical layer in a body of water where there is a rapid change in temperature with increasing depth. In the ocean, this zone separates the warmer, mixed surface layer from the much colder, deep water below. The thermocline acts as a physical barrier to vertical mixing, which can limit the transfer of nutrients from the deep sea to the sunlit surface. The depth and intensity of the thermocline vary with season and location and have significant impacts on the biological productivity and distribution of marine species in different oceanic regions.

237. (A) Gujarat
Gujarat has the longest coastline among all Indian states, stretching over 1,600 kilometers. This extensive coastal reach provides access to a wide range of marine environments and a vast continental shelf, which is highly productive due to seasonal upwelling and nutrient-rich inflows. The state's large coastline and well-developed fishing industry make it a leader in national marine capture production. Its diverse fisheries support the livelihoods of many coastal communities and contribute significantly to the state's economy and food security. Protecting and managing these vast coastal resources is a key priority for national and regional authorities.

238. (A) They breed naturally only in flowing riverine environments.
Indian Major Carps, such as Catla, Rohu, and Mrigal, have specialized reproductive requirements in their natural habitat. They are known as seasonal breeders that typically spawn in flowing riverine environments during the monsoon season, when water levels rise and conditions are favorable for the survival of their eggs and larvae. While they can be induced to breed in stagnant water through hormonal treatment, natural spawning in ponds is rare. This dependence on riverine flow is a critical factor in their biology and management, emphasizing the importance of maintaining river connectivity and healthy freshwater ecosystems for these species.

239. (A) Open sea
The term pelagic is derived from the Greek word pelagos, which means the open sea. In an ecological context, it refers to the vast water column of the ocean or a lake, away from the shore and the bottom. Organisms that live in this environment, such as sardines, tuna, and jellyfish, are called pelagic species. They are adapted for life in the water column and are not dependent on the seafloor for their survival. The pelagic zone is the largest habitat on earth and plays a critical role in global productivity, climate regulation, and biodiversity conservation.

240. (A) Severe tropical cyclones from the Bay of Bengal.
The east coast of India is highly vulnerable to severe tropical cyclones that develop in the Bay of Bengal, particularly during the pre-monsoon and post-monsoon periods. These intense storms bring high winds, heavy rain, and storm surges that create extremely hazardous conditions for fishing. For traditional and small-scale fleets, these events can result in significant loss of life, gear, and property, and can lead to many

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days where fishing is impossible. Managing the impacts of cyclones through better warning systems and disaster preparedness is essential for protecting the lives and livelihoods of coastal fishing communities.

241. (A) Property allowing small fish to escape meshes.
Mesh selectivity refers to the ability of a fishing net to capture certain sizes of fish while allowing others to pass through. By using a specific mesh size, fishers can target larger, marketable individuals while ensuring that smaller, juvenile fish are able to escape and continue growing. This is a critical tool in sustainable fishery management, as it helps prevent growth overfishing and protects the reproductive potential of the stock. Regulations often specify the minimum mesh size allowed for different gears to ensure that only sustainable levels and sizes of fish are harvested from the aquatic environment.

242. (A) Union Government (Central Government)
In India, the legal jurisdiction over fisheries is divided between state and central authorities. While individual coastal states manage the waters within the 12-nautical-mile territorial sea, the Union Government is responsible for the regulation of all activities within the remainder of the Exclusive Economic Zone, extending from 12 to 200 nautical miles. This includes the management of deep-sea resources, the licensing of larger vessels, and the implementation of international agreements and national policies for sustainable resource use. Coordination between central and state governments is essential for the effective management of shared fish stocks and marine ecosystems across the entire EEZ.

243. (A) Genetic markers (e.g., microsatellites or mtDNA).
Identifying discrete stocks within a single species is fundamental for effective fishery management, as different populations may have unique biological characteristics and response to fishing pressure. Genetic markers, such as mitochondrial DNA or microsatellites, provide the most reliable way to distinguish these groups. By analyzing the genetic variation among individuals from different locations, scientists can determine the degree of connectivity and isolation between populations. This information helps in defining appropriate management units and ensuring that each stock is harvested sustainably, preventing the loss of unique genetic lineages and maintaining the overall resilience and biodiversity of the species.

244. (A) To facilitate spawning migrations past the barrier.
Many riverine fish species must migrate upstream to reach their specific spawning and nursery grounds. The construction of dams and barrages acts as a physical barrier that can block these essential movements, leading to a decline in recruitment and potential local extinction. To mitigate these impacts, fish passes or fish ladders are often built to provide a route for fish to swim past the structure. These structures are designed to accommodate the swimming abilities of target species and are critical for maintaining river connectivity and supporting the survival of migratory fish populations in altered freshwater ecosystems worldwide.

245. (A) Water abstraction for irrigation, reducing river flow.
The Ganga river system faces significant ecological stress from the heavy abstraction of water for agricultural irrigation and other human uses. This leads to reduced flow, particularly during the dry season, which degrades the aquatic habitat and disrupts the natural life cycles of many fish species. The resulting loss of depth, connectivity, and water quality has contributed to a decline in the productivity and diversity of the river's fisheries. Addressing the challenges of water management and ensuring adequate environmental flows are critical for restoring the health of the Ganga and sustaining the fish resources that millions of people depend on.

246. (A) Maximum biomass an environment can sustain indefinitely.
Carrying capacity is an ecological concept that refers to the maximum population size or biomass of a species that an environment can support over the long term, given the available resources like food, habitat, and water. In an aquatic ecosystem, the carrying capacity is influenced by factors such as primary productivity, nutrient availability, and physical conditions. When a population reaches its carrying capacity, growth typically levels off as competition and other density-dependent factors increase. Understanding the carrying capacity is essential for modeling fish population dynamics, assessing the potential for aquaculture, and setting

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sustainable harvest limits for both capture and culture-based fisheries.

247. (A) Poisson distribution
In fishery research and monitoring, the capture of organisms in traps or nets often follows a random pattern that can be mathematically modeled using the Poisson distribution. This distribution is used to describe the probability of a specific number of events occurring within a given interval of time or space, such as the number of fish caught per trap. By applying this model, scientists can analyze catch data to estimate abundance, evaluate gear efficiency, and design more effective sampling surveys. It is a fundamental tool in the statistical analysis of ecological and fishery data, helping to improve our understanding of fish distribution and population dynamics.

248. (A) Reproduces only once and then typically dies.
Semelparity is a reproductive strategy where an organism invests all its energy into a single, massive reproductive event before dying. This strategy is found in various species across different taxa, most famously in Pacific salmon and some eels. By producing a large number of offspring in one go, these organisms maximize their chances of successful recruitment in specific environmental conditions. However, this also makes the population highly sensitive to any factors that disrupt their single chance to breed. Understanding these life history strategies is critical for developing conservation and management plans for semelparous species and for protecting their essential spawning and nursery habitats.

249. (A) Most perennial reef fishes (e.g., Groupers)
Iteroparity is a reproductive strategy where an organism can reproduce multiple times throughout its lifespan. This is the most common pattern among long-lived marine and freshwater fishes, such as groupers, snappers, and carps. By spawning over several years or seasons, these species spread the risk of recruitment failure and can maintain their populations even during periods of poor environmental conditions. This strategy also allows for the accumulation of experience and size, often leading to increased fecundity and higher-quality offspring in older individuals. Managing iteroparous species requires protecting the older, mature individuals that provide the greatest contribution to the population's reproductive potential and resilience.

250. (A) Close ecological association with the benthic substrate.
Demersal fishes are those that live on or near the bottom of the sea or a lake. They have a close ecological association with the benthic environment, where they find their food and shelter. Common examples include various flatfishes, croakers, and catfishes. These species have evolved specialized morphological and behavioral traits for a bottom-dwelling lifestyle, such as flattened bodies or sensory organs for detecting prey in the sediment. Demersal resources are primarily targeted by bottom-contact gears like trawls and longlines. Sustainable management of these fisheries must account for their sensitive habitats and the impact of fishing on the entire seafloor ecosystem and its biodiversity.

251. (A) European and American Eels (Anguilla spp.)
The Sargasso Sea in the North Atlantic is a unique oceanic region characterized by large mats of floating Sargassum seaweed. It is globally significant as the only known spawning ground for both European and American freshwater eels. These catadromous fishes undertake thousands of miles of migration from freshwater rivers across the ocean to reach this specific area to breed. Their larvae then drift back to coastal regions to complete their life cycle. Protecting the Sargasso Sea is critical for the survival of these iconic and threatened species, which are economically and culturally important across multiple continents and face various threats during their vast migrations.

252. (A) Buildup of toxic substances in an organism's tissues.
Bioaccumulation refers to the process by which certain substances, such as heavy metals or persistent organic pollutants, accumulate in the tissues of an organism over time. These chemicals are taken up from the water or food and are stored at concentrations higher than those found in the surrounding environment. This process is particularly significant in marine food webs, as it can lead to biomagnification, where concentrations increase at higher trophic levels. This can have serious health implications for apex predators and for humans who

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consume contaminated seafood. Monitoring bioaccumulation is essential for ensuring food safety and for managing the environmental health of aquatic ecosystems and their resources.

253. (A) Estuaries have riverine inflow; lagoons often lack them.
While both are coastal water bodies, estuaries and lagoons have distinct physical and ecological characteristics. An estuary is a semi-enclosed area where freshwater from a river meets and mixes with the sea, creating a dynamic salinity gradient. In contrast, a lagoon is a shallow body of water separated from the ocean by a barrier, such as a sandbar or coral reef, and often lacks a significant source of freshwater inflow. This difference influences the nutrient levels, salinity patterns, and species composition of each system. Both are critical habitats and support important fisheries, requiring specialized management to protect their unique biological diversity and environmental health in diverse coastal regions.

254. (A) Shore seine
Shore seining is a traditional fishing method where a large net is deployed from a boat and then pulled back to the shore by a group of people. This technique has been used for centuries along the Indian coast to capture various pelagic and nearshore species. While it is an active capture method, it is limited to the shallow waters and has a relatively low environmental impact compared to mechanized offshore trawling. Shore seines play an important social and economic role in many coastal communities, providing food and employment. However, their use must be managed to avoid overexploitation of nearshore resources and to ensure the sustainability of traditional fishing livelihoods.

255. (A) Within the inner ear chamber of a teleost fish.
Otoliths are small, calcified structures located in the inner ear of bony fishes. They function as part of the animal's sensory system for hearing and balance. For fisheries scientists, otoliths are invaluable tools because they grow throughout the fish's life and develop annual or even daily rings. By analyzing these rings, researchers can determine the age and growth history of individual fish with great precision. This information is fundamental for building the population models used in stock assessments and for setting sustainable harvest levels. Otoliths also store chemical clues about the environmental conditions the fish has experienced, providing insights into its migration and habitat use.

256. (A) Z = Natural Mortality (M) + Fishing Mortality (F)
Total mortality represents the overall rate at which fish are removed from a population. In a managed fishery, this rate is the sum of natural mortality, which includes all causes of death other than fishing, and fishing mortality, which is the removal of fish by commercial and recreational activities. Accurate estimation of Z, and its components M and F, is essential for understanding the population dynamics of a stock and for determining its sustainability. If fishing mortality is too high relative to natural mortality and recruitment, the stock may become overexploited. Monitoring these rates allows managers to adjust fishing effort and catch limits to protect the resource for the future.

257. (A) Total prohibition to allow recovery and larval spillover.
A no-take zone is a specific type of Marine Protected Area where all extractive activities, including fishing, are completely prohibited. The primary ecological goal of these zones is to provide a total refuge where fish populations can increase in size, biomass, and reproductive potential without human interference. As the stock grows, it can help replenish the surrounding fished areas through the movement of adult fish and the dispersal of larvae, a process known as spillover. No-take zones are powerful tools for restoring depleted fisheries, protecting sensitive habitats, and enhancing the overall resilience and biodiversity of the marine environment for long-term ecological and economic benefits.

258. (A) Etroplus suratensis (Pearl spot)
Euryhaline species are organisms that can tolerate a wide range of salinity levels, allowing them to thrive in the dynamic environments of estuaries and backwaters. The Pearl spot is a classic example of a euryhaline fish found along the southwestern coast of India. It can successfully live and reproduce in freshwater, brackish water, and even marine conditions. This flexibility makes it highly adaptable to the seasonal changes in salinity that occur in estuarine systems. The Pearl spot is a commercially important species in both capture fisheries and aquaculture and is highly valued

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for its taste and cultural significance, requiring careful management to ensure its continued abundance and sustainability.

259. (A) Determining egg production increases relative to length.
The fecundity-length relationship is a mathematical model used in fishery biology to describe how the reproductive capacity of a fish, or its fecundity, changes as it grows in size. In most species, larger females produce significantly more eggs than smaller ones. Understanding this relationship is critical for estimating the total reproductive potential of a stock and for assessing the impact of different fishing strategies on future recruitment. By protecting larger, more fecund individuals, managers can help ensure that the population maintains its ability to replenish itself and withstand environmental changes. This relationship is a key input for the population models used to evaluate the status and sustainability of fish resources.

260. (A) Upwelling
Upwelling is an oceanographic phenomenon driven by the movement of surface waters away from the coast or a specific area, usually by wind and the Coriolis effect. This displacement allows deeper, colder, and nutrient-rich water to rise from the depths to the sunlit surface layer. The sudden influx of nutrients stimulates massive blooms of phytoplankton, which form the base of a highly productive marine food web. Upwelling regions are among the most biologically rich and commercially important areas in the ocean, supporting large populations of fish and higher trophic level predators. Understanding the timing and intensity of upwelling is essential for predicting fishery yields and managing the world's most productive marine resources.

261. (A) Tamil Nadu
The Gulf of Mannar is a significant marine biosphere reserve located off the southeastern coast of India, in the state of Tamil Nadu. It is renowned for its incredible biodiversity, including extensive coral reefs, seagrass beds, and mangrove forests. The region supports a wide variety of marine life, such as the endangered dugong, sea cucumbers, and numerous species of fish and shellfish. Historically, it was famous for its pearl oyster beds. The Gulf of Mannar is also a critical area for local fisheries, supporting the livelihoods of many coastal communities. Protecting this fragile and diverse ecosystem from threats like overfishing and pollution is a major priority for national and international conservation efforts.

262. (A) Fraction of stock caught by one unit of fishing effort.
The catchability coefficient is a key parameter in fishery mathematics that relates the catch per unit effort to the actual abundance of the fish stock. It represents the efficiency of a single unit of effort, such as one hour of trawling or one boat day, in capturing a portion of the population. Catchability can be influenced by many factors, including the type of gear, the behavior of the fish, and environmental conditions. It is also affected by technological improvements, which can increase the efficiency of fishing over time. Accurate estimation of catchability is essential for using CPUE as a reliable index of stock abundance and for developing effective management strategies that account for changes in fishing power.

263. (A) They are rot-resistant, stronger, and less visible.
The transition from natural fibers like cotton and hemp to synthetic materials such as nylon and polyethylene revolutionized the fishing industry in the mid-20th century. Synthetic fibers are highly durable and resistant to biological decay, which means nets do not need to be dried and treated as frequently. They are also much stronger, allowing for larger and more powerful gears to be used. Additionally, synthetic twines can be made thinner and less visible to fish, increasing the catch efficiency of many types of gear, such as gillnets and lines. While these properties have significantly increased fishery production, they have also contributed to problems like ghost fishing and increased environmental impact, requiring better management and gear retrieval programs.

264. (A) Economic overfishing
Economic overfishing occurs when the level of fishing effort is so high that it exceeds the point of maximum economic yield. In an open-access fishery, the entry of more vessels continues as long as there is any profit to be made. This leads to excessive capitalization and effort, which eventually dissipates the economic rent or profit that the resource could potentially provide. The result is a fishery that is biologically overexploited and financially unstable, where individual fishers

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barely cover their costs. Sustainable management aims to address this by implementing regulations such as limited entry, quotas, and rights-based systems to reduce effort to a level that maximizes the economic value of the resource and ensures the long-term viability of the fishing industry.

265. (A) Struggle to find mates at excessively low densities.
The Allee effect describes a phenomenon in population biology where the per capita growth rate of a population decreases as its density becomes very low. For many marine species, this occurs when individuals are so widely dispersed that they struggle to find mates for reproduction. This can lead to a further decline in the population and increase the risk of local extinction, even if fishing pressure is reduced. The Allee effect is a serious concern for heavily depleted stocks, as it can hinder their recovery and make them more vulnerable to environmental changes. Fisheries management must account for these density-dependent interactions to ensure that fish populations are maintained at levels high enough to support successful reproduction and the long-term sustainability of the resource.

266. (A) The UN Fish Stocks Agreement (UNFSA) of 1995
The United Nations Fish Stocks Agreement is a key international treaty that provides the legal framework for the conservation and management of fish populations that cross national maritime boundaries. Specifically, it addresses straddling fish stocks and highly migratory species, which move between Exclusive Economic Zones and the high seas. The agreement emphasizes the need for international cooperation and the use of a precautionary approach to management. It also outlines the role of regional fishery management organizations in setting catch limits and ensuring compliance. By providing a consistent set of rules for the exploitation of shared resources, the UNFSA aim to prevent overfishing and ensure the long-term sustainability and health of global marine ecosystems across multiple jurisdictions.

267. (A) Brachyuran crustacean
The mud crab belongs to the infraorder Brachyura, which includes the true crabs characterized by a reduced abdomen tucked under a broad, flattened cephalothorax. These crustaceans are highly valued for their meat and are a significant resource in both capture fisheries and aquaculture across the Indo-Pacific region, including India. They inhabit estuarine and mangrove environments and have a complex life cycle that involves a migration to the open ocean for spawning. Mud crabs are known for their large, powerful claws and aggressive behavior. Accurate biological classification is essential for understanding their ecology and for developing sustainable management and farming practices that account for their unique life history and habitat requirements.

268. (A) Low fecundity and extremely long gestation periods.
Deep-water sharks have life history traits that make them among the most vulnerable of all marine species to overfishing. Unlike many bony fishes that produce millions of eggs, these sharks typically have very low fecundity and prolonged gestation periods, often lasting several years. They also grow slowly and reach sexual maturity at a late age. These K-selected traits mean that their populations have a very low capacity to recover once they are depleted. Because they are often caught as bycatch in deep-sea trawling or targeted for their liver oil and fins, many deep-water shark species are now highly threatened. Conservation efforts must prioritize the protection of these slow-growing predators through strict catch limits and the use of protected areas.

269. (A) Stock-Recruitment relationship
The Beverton-Holt and Ricker models are the two classical mathematical representations used in fisheries science to describe the relationship between the spawning stock biomass and the number of offspring that eventually enter the fishery. These models account for density-dependent processes, such as competition and cannibalism, that influence the survival of eggs and larvae. While the Beverton-Holt model assumes that recruitment levels off as biomass increases, the Ricker model predicts a decline at high densities. Understanding these relationships is fundamental for stock assessments, as they help determine the minimum spawning biomass needed to sustain a population and guide the setting of harvest limits to prevent recruitment overfishing and ensure the long-term productivity of the resource.

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270. (A) Examines yield per recruit against mortality levels.
A yield per recruit model is an analytical tool used in fisheries stock assessment to evaluate how the total harvest from a single cohort changes under different levels of fishing mortality and age at first capture. It helps identify the optimal strategy to maximize the weight of the fish caught relative to the number of young fish that enter the population. By analyzing the balance between growth and mortality, the model can provide guidance on setting minimum size limits and managing fishing effort to achieve the most efficient use of the resource. While it does not predict total abundance, it is a key component of the management framework for many commercial fish stocks, helping to prevent growth overfishing and optimize long-term yields.

271. (A) Unintentional introduction of invasive alien species.
Ballast water is taken on by large ships to maintain stability during their voyages. When this water is discharged at a new location, it can release a wide variety of marine organisms, including bacteria, algae, and larvae of fish and invertebrates, into a different ecosystem. This is a major pathway for the introduction of invasive alien species, which can outcompete native organisms, disrupt local food webs, and cause significant ecological and economic damage. Managing ballast water through treatment and exchange programs is a critical international priority to prevent the spread of harmful aquatic species and to protect the biodiversity and health of coastal and marine environments worldwide.

272. (A) Mortality rate producing the maximum yield per recruit.
In a yield per recruit analysis, $F_{\max}$ is the specific level of fishing mortality that results in the maximum possible average catch from each fish that enters the population. It is a biological reference point used to evaluate whether a stock is being harvested at an optimal level to maximize its physical yield. If the current fishing mortality is higher than $F_{\max}$, the stock is considered to be suffering from growth overfishing, meaning that fish are being caught too small and too fast. While $F_{\max}$ is an important target for some management systems, others may use more precautionary reference points to account for the risk of recruitment failure and to ensure the overall stability and health of the fish population over time.

273. (A) Sudden catastrophic water temperature changes.
In population dynamics, factors that affect a population regardless of its density are called density-independent factors. These are typically environmental events, such as extreme weather, volcanic eruptions, or sudden changes in water temperature, that cause mortality in a way that is not related to how many individuals are in the area. In contrast, density-dependent factors like competition and disease become more intense as the population grows. Understanding both types of impacts is essential for modeling fish populations and predicting how they will respond to environmental variability and human activities. While density-dependent factors often provide a level of self-regulation, density-independent events can cause sudden and unpredictable shifts in abundance and productivity, requiring flexible and precautionary management strategies.

274. (A) They rely exclusively on catching microscopic prey.
Seaweeds are macroscopic, multicellular marine algae that are essential primary producers in coastal ecosystems. Unlike animals, they do not catch prey; instead, they produce their own food through photosynthesis using sunlight and nutrients from the water. They are classified into three main groups—green, brown, and red algae—based on their specific pigments. Seaweeds lack the true roots, stems, and leaves characteristic of higher terrestrial plants, using a holdfast to attach to rocky substrates. They provide critical habitats for many marine species and are harvested globally for food, industrial chemicals, and fertilizers. Understanding their biology and ecology is fundamental for managing seaweed resources and protecting the sensitive coastal environments where they grow.

275. (A) Salt wedge or stratification
A salt wedge occurs in certain estuarine systems where the outflow of freshwater is strong and the tidal movement is relatively low. Because freshwater is less dense than saltwater, it forms a surface layer that flows over a deeper, wedge-shaped layer of higher-salinity marine water that pushes upstream along the bottom. This vertical stratification can have significant ecological effects, as it creates distinct habitats

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with different salinity and oxygen levels. It also influences the movement of larvae and nutrients within the estuary. Understanding the physical dynamics of salt wedges is essential for managing estuarine fisheries and for predicting how changes in river flow or sea level will impact these complex and productive coastal ecosystems.

276. (A) Surplus Production (Biomass Dynamic) models
The Schaefer and Fox models are the most well-known examples of surplus production models, also called biomass dynamic models, used in fishery stock assessments. These models treat the entire population as a single unit of biomass and relate its growth and productivity directly to its current size. They require only historical data on total catch and fishing effort over several years to estimate parameters like maximum sustainable yield and optimal fishing effort. While they do not account for the age or size structure of the population, surplus production models provide a practical and effective way to assess the status of many fish stocks, particularly in data-poor situations where detailed biological information is not available.

277. (A) Dol net (a stationary bag net)
The dol net is a traditional and highly specialized fishing gear used extensively along the northwest coast of India, particularly in Gujarat and Maharashtra. It is a large, stationary bag net that is anchored to the seafloor and held open by the force of strong tidal currents. As the tide flows in or out, fish and other organisms are swept into the net and collected in the codend. This gear is the primary method used to capture the Bombay duck, which is a key commercial resource in the region. The operation of dol nets is closely tied to the lunar and tidal cycles, and they are a vital part of the local economy and traditional fishing culture.

278. (A) Dividing the MPA into distinct sectors with protection levels.
Zonation is a management strategy used in Marine Protected Areas to balance the needs of conservation with other human activities. It involves dividing the MPA into different sectors, each with its own set of rules and levels of protection. For example, some zones may be strictly no-take areas to protect sensitive habitats and breeding stocks, while others may allow for sustainable artisanal fishing, tourism, or research. This approach helps reduce conflict between different users and ensures that the most critical ecological features are protected while still providing social and economic benefits. Effective zonation requires careful planning and the involvement of local communities to ensure compliance and to achieve the long-term goals of the MPA.

279. (A) Gear quantity used on grounds over a unit of time.
Fishing effort is a quantitative measure of the total amount of fishing activity applied to a particular stock or area during a specific period. It can be expressed in various units, such as the number of hours trawled, the number of hooks deployed, or the number of days a vessel spent at sea. Accurate measurement of effort is essential for calculating the catch per unit effort, which serves as an index of stock abundance. Managing fishing effort is a primary way that authorities control the total harvest and prevent overexploitation. By regulating factors like the number of licenses, the length of the fishing season, and the type of gear used, managers can ensure that the pressure on the resource remains sustainable and that the long-term productivity of the fishery is protected.

280. (A) Shattered slow-growing structures take decades to recover.
Coral reefs are among the most diverse and productive ecosystems on earth, but they are also highly sensitive to physical damage. Destructive practices like dynamite fishing use explosives to kill fish, but the shockwaves also shatter the complex calcium carbonate skeletons of the corals. Because corals grow very slowly—often only a few millimeters or centimeters per year—it can take decades for a reef to recover from even a single blast. This loss of structural complexity destroys the essential habitat for countless other species and leads to a long-term decline in the productivity and biodiversity of the reef. Protecting coral reefs from such destructive methods is a critical priority for marine conservation and for the sustainability of the many fisheries that depend on these fragile underwater environments.

281. (A) Total weight of mature, reproducing fish in the stock.
Spawning stock biomass is a critical biological reference point used in fisheries science to

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evaluate the reproductive potential and health of a fish population. It represents the total weight of all the individuals in the stock that are old and large enough to reproduce. Maintaining a sufficient SSB is essential for ensuring that the population can produce enough offspring to replenish itself and withstand environmental variability. If the SSB falls below a certain threshold, the risk of recruitment failure and population collapse increases significantly. Management aims to keep the SSB at a level that supports the long-term sustainability of the fishery, often through measures like catch limits, size regulations, and the protection of spawning grounds and periods.

282. (A) Kochi, Kerala
The Central Marine Fisheries Research Institute is India's leading organization for marine fisheries research and management. Its headquarters is located in Kochi, Kerala, which is a major hub for the nation's fishing industry. CMFRI is responsible for monitoring marine fish landings, assessing the status of major stocks, and providing scientific advice to the government for the sustainable management of India's vast marine resources within the Exclusive Economic Zone. Through its various regional and field stations, the institute conducts extensive research on biology, oceanography, mariculture, and socio-economics, playing a vital role in ensuring the long-term health and productivity of India's marine environment and the livelihoods of the millions of people who depend on it.

283. (A) Holistic management of species, habitat, and humans.
The Ecosystem Approach to Fisheries represents a shift in management from focusing solely on individual target species to considering the broader ecological, social, and economic context of fishing. It aims to ensure that fisheries are managed in a way that preserves the health and functioning of the entire marine ecosystem, including non-target species and habitats. This holistic strategy involves accounting for the impacts of fishing on biodiversity, the interactions between different species, and the needs and well-being of the communities that depend on the resource. By taking a more integrated and precautionary approach, the EAF aims to enhance the resilience and sustainability of both the environment and the fishing industry for future generations, ensuring that marine resources are protected and used responsibly.

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284. (A) Neritic zone
The neritic zone is the part of the marine environment that extends from the low-tide mark to the edge of the continental shelf, typically reaching depths of up to 200 meters. Because it is shallow and often well-oxygenated and nutrient-rich due to coastal runoff and mixing, it is the most productive part of the ocean. It supports a vast majority of the world's marine biodiversity and is the source of most commercial fish and shellfish landings. The neritic zone includes various critical habitats such as coral reefs, seagrass beds, and kelp forests. Protecting this zone from threats like pollution, habitat destruction, and overfishing is essential for maintaining the overall health of the global marine ecosystem and the sustainability of human coastal activities and livelihoods.

285. (A) Length increase relative to age toward a maximum.
The von Bertalanffy growth function is the most widely used mathematical model in fisheries science for describing how the length of a fish increases over time. It assumes that growth is rapid early in life and slows down as the fish approaches its theoretical maximum size, or asymptotic length. By fitting this model to age-length data, scientists can estimate parameters like the growth coefficient, which indicates how quickly the fish reaches its maximum size. Understanding these growth patterns is essential for building population models, estimating mortality and productivity, and for setting sustainable harvest targets. It is a fundamental tool for evaluating the status of fish stocks and for developing management strategies that account for the biological characteristics and life history of different species across diverse aquatic environments.

286. (A) Deep-sea environments susceptible to gear damage.
Vulnerable Marine Ecosystems are deep-sea habitats that are characterized by unique biological communities and physical structures that are highly sensitive to human activities, particularly bottom-contact fishing. Examples include deep-sea coral reefs, sponge fields, and hydrothermal vents. Because these ecosystems are often composed of slow-growing and long-

lived species, they have a very low capacity to recover from physical disturbance. International regulations and regional management organizations have established criteria to identify VMEs and implement protective measures, such as closing these areas to bottom trawling and other destructive gears. Protecting VMEs is a critical component of global efforts to preserve deep-sea biodiversity and ensure the long-term ecological integrity of the world's least explored and most fragile oceanic environments for the future.

287. (A) Laterally compressed, asymmetrical adult body forms.
The order Pleuronectiformes, commonly known as flatfishes, is one of the most distinctive groups of vertebrates. They are characterized by a remarkable asymmetry in their adult form, where both eyes are located on one side of a laterally compressed body. This unique body shape allows them to lie flat on the seafloor with both eyes positioned to look upward for prey or predators. This specialized adaptation is a result of a dramatic metamorphosis that occurs during their larval stage. Flatfishes are primarily benthic species and include many commercially important groups like soles, flounders, and halibuts. Understanding their unique biology and life history is essential for managing their fisheries and for protecting the benthic habitats on which they depend for their survival and productivity.

288. (A) The relationship between the length of the netting and the length of the rope it is attached to.
The hanging ratio is a critical technical parameter in the design and construction of fishing nets, such as gillnets and trawls. it is the ratio of the length of the headline or footrope to the stretched length of the netting that is attached to it. By adjusting the hanging ratio, net makers can control the shape and openness of the meshes, which in turn influences the gear's selectivity, catch efficiency, and drag in the water. A lower hanging ratio typically results in a baggier net with more open meshes, which can be more effective for entangling certain fish. Accurate understanding and control of the hanging ratio are essential for developing selective and responsible fishing gears that target specific species and sizes of fish while minimizing bycatch and environmental impact.

289. (A) Croakers / Jewfishes (Sciaenidae)
Members of the family Sciaenidae, which includes croakers and jewfishes, are highly valued in both domestic and international markets. A unique feature of many species in this group is their large and well-developed swim bladder, or air bladder. In certain regions, these bladders are processed and dried to produce isinglass, which is used in the clarification of wine and beer and is highly prized in traditional medicine and cuisine, particularly in Asia. This high value has led to the development of specialized fisheries and has sometimes resulted in intense fishing pressure on certain sciaenid stocks. Managing these resources requires careful consideration of both the value of the meat and the secondary products to ensure that harvest levels remain sustainable and that the biological health of the population is protected.

290. (A) Malabar Coast - Southwest Monsoon induced upwelling.
The Malabar coast along the southwestern part of India is one of the most productive marine regions in the world. Its high productivity is driven primarily by the oceanographic processes associated with the southwest monsoon. During this season, winds and currents induce intense coastal upwelling, which brings cold, nutrient-rich deep water to the sunlit surface. This massive influx of nutrients stimulates the growth of phytoplankton, supporting vast populations of pelagic fishes like the Indian oil sardine and Indian mackerel. Understanding the relationship between these large-scale climatic and oceanographic drivers and the seasonal fluctuations in fish abundance is essential for managing the regional fisheries and for ensuring the food security and livelihoods of the many communities that depend on these vital marine resources.

291. (A) Swim bladder
The swim bladder is a specialized gas-filled organ found in most teleost fishes that allows them to control their buoyancy and maintain their position in the water column without expending energy for swimming. By adjusting the volume of gas in the bladder, the fish can match its density to that of the surrounding water, allowing it to float at a specific depth. This unique adaptation is critical for various activities, including feeding, migrating, and avoiding predators. Some fishes also use the swim bladder for sound production

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or as a sensory organ for hearing. While not present in cartilaginous fishes like sharks, the swim bladder is a fundamental feature of bony fish biology and plays a key role in their ecological success across diverse aquatic environments.

292. (A) Food and Agriculture Organization (FAO)
The Food and Agriculture Organization of the United Nations is the primary international body responsible for monitoring and reporting on the global status of aquatic resources. One of its most significant publications is the biennial State of World Fisheries and Aquaculture (SOFIA) report. This comprehensive document provides a detailed analysis of global catch statistics, aquaculture production, stock status, and emerging trends and challenges in the sector. The SOFIA report is an essential resource for policymakers, scientists, and industry stakeholders worldwide, providing the evidence base for international agreements, national policies, and management strategies aimed at ensuring the long-term sustainability and contribution of fisheries and aquaculture to global food security and economic development.

293. (A) Intense intraspecific competition for limited food.
Density-dependent mechanisms are biological processes where the effect on a population changes according to the number of individuals in a given area. Intraspecific competition is a primary example, where members of the same species compete for a limited supply of food, habitat, or other essential resources. As the population density increases, this competition becomes more intense, leading to slower growth, reduced fecundity, or higher mortality, which naturally helps to regulate the population size toward the environment's carrying capacity. Understanding these intrinsic mechanisms is fundamental for modeling fish population dynamics and for setting sustainable harvest levels. By accounting for how populations self-regulate, fishery managers can better predict how stocks will respond to fishing pressure and environmental changes and ensure their long-term health and productivity.

294. (A) Removing BOFFFFs severely damages reproductive potential.
The Big Old Fat Fertile Female Fish (BOFFFF) hypothesis highlights the ecological importance of maintaining the larger and older individuals in a fish population. These females are not only more fecund, producing far more eggs than younger ones, but their offspring are often of higher quality and have better survival rates. Furthermore, older individuals can provide stability to the population by spawning over a longer season or across more varied locations. Selectively targeting these BOFFFFs through size-selective fishing can severely compromise the reproductive potential and resilience of the entire stock. Modern management frameworks are increasingly recognizing the need to protect these critical individuals, often through the use of maximum size limits or protected areas, to ensure the long-term sustainability and health of the fish population.

295. (A) Scleractinian (stony) corals
Scleractinian corals, also known as stony corals, are the primary builders of coral reef ecosystems. These colonial organisms secrete a hard skeleton of calcium carbonate, which over thousands of years forms the massive and complex structural foundation of the reef. This structure provides critical habitat, shelter, and feeding grounds for a vast majority of marine species. Stony corals have a symbiotic relationship with microscopic algae called zooxanthellae, which provide them with nutrients through photosynthesis and give them their vibrant colors. Because they are the foundational species of the reef, the health and survival of scleractinian corals are essential for maintaining the entire marine community and the diverse fisheries it supports. Protecting these corals from stressors like climate change, pollution, and destructive fishing is a top priority for marine conservation.

296. (A) Fishery with no entry barriers, causing overexploitation.
In fisheries economics, an open-access fishery is one where there are no restrictions on who can participate or how much can be harvested. In this situation, the resource is treated as a common pool with no individual property rights. This often leads to a race to fish, where individual fishers have an incentive to capture as much as possible before others do. The result is typically excessive effort, overcapitalization, and the eventual depletion of the stock, a phenomenon known as the tragedy of the commons. Because there is no incentive for individual conservation, open-access fisheries are highly susceptible to both biological and economic failure. Sustainable

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management aim to address this by implementing entry barriers, such as licensing and quota systems, to ensure that fishing pressure is controlled and the resource is shared responsibly.

297. (A) Microscopic organisms drifting passively with currents.
Plankton refers to a diverse group of organisms that live in the water column and are incapable of swimming against the prevailing ocean currents. This group is divided into two main categories: phytoplankton, which are primary producers that perform photosynthesis, and zooplankton, which are animals that feed on phytoplankton and each other. Plankton range in size from microscopic bacteria and algae to larger organisms like jellyfish. They form the foundational base of almost all aquatic food webs and play a critical role in global biological productivity and carbon cycling. The distribution and abundance of plankton are influenced by factors like sunlight, nutrients, and water movement. Understanding plankton dynamics is essential for studying the overall health and productivity of marine and freshwater ecosystems and for managing the fisheries that depend on them.

298. (A) They exhibit slow growth compared to demersal finfishes.
Cephalopods, such as squids and octopuses, are characterized by their extremely rapid growth and short lifespans, which is the opposite of many demersal finfishes. Most species complete their entire life cycle in just one or two years. This high rate of production means that their populations can increase very quickly under favorable conditions but can also fluctuate wildly from year to year in response to environmental changes. Cephalopods are highly active predators and are a significant component of both marine food webs and commercial fisheries worldwide. Their rapid demographic shifts require flexible and responsive management strategies that account for their unique life history traits. Understanding these biological patterns is essential for the sustainable exploitation and conservation of these versatile and economically important marine resources across all ocean basins.

299. (A) Meristic characters
In fish taxonomy and biology, meristic characters are the discrete, countable features of a fish's anatomy used for species identification and stock discrimination. These include the number of rays and spines in the fins, the number of scales along the lateral line, and the number of gill rakers on the first gill arch. Unlike morphometric characters, which are measurements of body shape and size that can change with age and environment, meristic counts are usually fixed early in life and remain constant. This makes them highly reliable tools for distinguishing between closely related species and for studying the geographic variation within a population. Accurate meristic analysis is fundamental for systematic research, the development of identification keys, and for ensuring the correct labeling and management of diverse aquatic resources in capture and culture fisheries.

300. (B) 24 nautical miles
The contiguous zone is a maritime area adjacent to the territorial sea where a coastal state can exercise the control necessary to prevent and punish infringements of its customs, fiscal, immigration, or sanitary laws and regulations. According to the United Nations Convention on the Law of the Sea, the contiguous zone may not extend beyond 24 nautical miles from the baseline from which the breadth of the territorial sea is measured. This means it can extend up to an additional 12 nautical miles beyond the territorial sea itself. This zone provides states with an extra layer of jurisdiction to protect their national interests and ensure compliance with their laws in the waters near their coasts. Understanding these maritime boundaries is essential for national security, law enforcement, and the effective management of coastal and marine activities and resources.

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CHAPTER 02
Fish Biology and Physiology

2005
1. According to the International Code of Zoological Nomenclature, which principle ensures that the oldest valid name of a species is retained?
(A) Principle of Synonymy
(B) Principle of Priority
(C) Principle of Homonymy
(D) Principle of Typification

2004
2. Which classic meristic character is frequently used to differentiate closely related finfish species?
(A) Body depth
(B) Head length
(C) Eye diameter
(D) Number of lateral line scales

2014
3. What mechanism of speciation occurs when a physical barrier divides a continuous fish population into two isolated groups?
(A) Allopatric speciation
(B) Sympatric speciation
(C) Parapatric speciation
(D) Peripatric speciation

2007
4. In the teleost ovary, which cell layer immediately surrounds the developing oocyte and is responsible for vitellogenin uptake?
(A) Theca layer
(B) Oogonia
(C) Granulosa layer
(D) Spermatogonia

2011
5. The androgenic gland in crustaceans is primarily responsible for which physiological process?
(A) Male differentiation
(B) Female maturation
(C) Molting control
(D) Osmotic balance

2018
6. Which hormone is released by the hypothalamus to stimulate the pituitary gland in the teleost HPG axis?
(A) Luteinizing hormone
(B) Follicle-stimulating hormone
(C) Maturation-inducing steroid
(D) Gonadotropin-releasing hormone

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2010
Eyestalk ablation in penaeid shrimps accelerates gonadal maturation by removing the source of which hormone?
(A) Molt-inhibiting hormone
(B) Gonad-inhibiting hormone
(C) Gonad-stimulating hormone
(D) Methyl farnesoate hormone

2015
8. The Gonadosomatic Index is calculated as the ratio of gonad weight to which other parameter?
(A) Total liver weight
(B) Total brain weight
(C) Total body weight
(D) Total gut weight

2005
9. A high relative gut length in a fish typically indicates which feeding habit?
(A) Carnivorous
(B) Piscivorous
(C) Insectivorous
(D) Herbivorous

2004
10. Consider the following statements regarding teleost embryogenesis:
I. Cleavage is strictly holoblastic.
II. Cleavage is meroblastic and discoidal.
III. The blastodisc forms at the animal pole.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I only

2004
11. Which larval stage of penaeid shrimp immediately follows the nauplius stage?
(A) Mysis
(B) Zoea
(C) Postlarva

(D) Megalopa

2022
12. Which hard structure is most reliable for determining the daily age of larval fishes?
(A) Scales
(B) Otoliths
(C) Vertebrae
(D) Fin spines

2013
13. In the von Bertalanffy growth equation, what does the parameter L_∞ represent?
(A) Asymptotic length
(B) Initial length at birth
(C) Growth coefficient
(D) Maximum observed length

2010
14. Which factor is considered a component of Natural Mortality in fish populations?
(A) Trawling
(B) Bycatch
(C) Predation
(D) Gillnetting

2006
15. The Beverton-Holt model is primarily used to estimate which population dynamic parameter?
(A) Migration rate
(B) Recruitment
(C) Digestion rate
(D) Mutation rate

2007
16. A fish species that migrates from freshwater to the ocean to spawn is classified as what?
(A) Anadromous
(B) Amphidromous
(C) Catadromous
(D) Oceanodromous

2025
17. Which type of fish pass utilizes a series of resting pools separated by low weirs?
(A) Denil fishway
(B) Vertical slot fishway
(C) Pool and weir fishway
(D) Fish elevator

2010
18. What does PIT stand for in the context of fish tagging?
(A) Position Indicating Transmitter
(B) Population Index Tag
(C) Pulse Intensity Tracker
(D) Passive Integrated Transponder

2004
19. Potential Fishing Zone advisories primarily integrate satellite data on Sea Surface Temperature and which other parameter?
(A) Salinity
(B) Chlorophyll-a concentration
(C) Dissolved oxygen
(D) Turbidity

2005
20. Consider the following statements regarding Vessel Monitoring Systems in fisheries:
I. They transmit real-time location data.
II. They rely strictly on acoustic waves.
III. They are a core component of Surveillance.
IV. They measure fish growth directly.
Which of the above statement(s) is/are correct?
(A) I, II and III
(B) I and III
(C) II, III and IV
(D) I, III and IV

2017
21. During DNA extraction, what is the primary function of proteinase K?
(A) Protein digestion
(B) DNA precipitation
(C) RNA degradation
(D) Cell membrane synthesis

2015
22. Which mitochondrial gene is the standard marker for DNA barcoding in animals, including fishes?
(A) 16S ribosomal RNA
(B) Cytochrome b protein
(C) 12S ribosomal RNA
(D) Cytochrome c oxidase I

2019
23. Microsatellites are highly polymorphic genetic markers consisting of what structural feature?
(A) Short tandem repeats
(B) Single nucleotide substitutions
(C) Large chromosomal inversions
(D) Telomeric ends

2002
24. Which taxonomic category ranks immediately below Family in the standard classification of fishes?
(A) Order
(B) Class
(C) Genus
(D) Phylum

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2009

25. Morphometric characters differ from meristic characters because morphometrics are based on what?
(A) Measurements
(B) Counts
(C) Colors
(D) Behaviors

2021

26. Which evolutionary concept describes unrelated fish species developing similar traits due to shared environments?
(A) Divergent evolution
(B) Convergent evolution
(C) Parallel evolution
(D) Coevolution

2007

27. Spermatogenesis in male teleosts occurs within which specific testicular structures?
(A) Ovarian follicles
(B) Leydig cells
(C) Sertoli cells
(D) Seminiferous lobules

2002

28. In bivalve molluscs, the crystalline style plays a crucial role in which physiological process?
(A) Reproduction
(B) Respiration
(C) Digestion
(D) Excretion

2015

29. The synthesis of vitellogenin in teleosts occurs primarily in which organ?
(A) Ovary
(B) Pituitary
(C) Kidney
(D) Liver

2016

30. Consider the following statements concerning crustacean molting:
I. Ecdysone stimulates molting.
II. The X-organ inhibits molting.
III. The Y-organ produces ecdysteroids.
IV. Molting strictly halts reproduction.
V. Eyestalk ablation delays molting.
Which of the above statement(s) is/are correct?
(A) I, II and III
(B) I, II, III and IV
(C) II, IV and V
(D) I, III, IV and V

2015

31. Absolute fecundity refers to the total number of what entity in a female fish?
(A) Yearly spawned eggs
(B) Mature ova in ovary
(C) Successfully hatched fry
(D) Oocytes per gram body

2019

32. The Gastrosomatic Index is most useful for determining which aspect of fish biology?
(A) Feeding intensity
(B) Spawning frequency
(C) Growth rate
(D) Migration pattern

2005

33. Epiboly is a morphogenetic movement characterizing which stage of fish embryonic development?
(A) Gastrulation
(B) Cleavage
(C) Organogenesis
(D) Hatching

2025

34. The veliger larval stage is unique to which group of aquatic organisms?
(A) Teleosts
(B) Crustaceans
(C) Echinoderms
(D) Molluscs

2016

35. Annuli formation on fish scales is typically caused by variations in what environmental parameter?
(A) Temperature
(B) Salinity
(C) Dissolved oxygen
(D) Light intensity

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2004

36. An isometric length-weight relationship in fish is indicated when the exponent parameter equals what value?
(A) 1.0
(B) 2.0
(C) 3.0
(D) 4.0

2019

37. Total mortality is mathematically represented as the sum of natural mortality and which other factor?
(A) Predation mortality
(B) Fishing mortality
(C) Disease mortality

(D) Senescence mortality

2016
38. In the Ricker recruitment model, recruitment declines at very high stock sizes due to what ecological interaction?
(A) Symbiosis
(B) Cannibalism
(C) Mutualism
(D) Commensalism

2010
39. Oceanodromous fish perform their migrations entirely within which environment?
(A) Marine waters
(B) Freshwater rivers
(C) Estuaries
(D) Riparian zones

2002
40. The following question consists of two statements, one labelled as Assertion (A) and the other labelled as Reason (R).
Assertion (A): Denil fishways are highly effective for upstream migration of diverse fish species.
Reason (R): Denil fishways utilize U-shaped baffles to reduce water velocity, allowing smaller fish to ascend.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2003
41. Acoustic tagging relies on the transmission of sound waves to track fish. What limits its effectiveness in highly aerated water?
(A) Signal attenuation
(B) Battery life
(C) Tag rejection
(D) Predation risk

2007
42. Satellite telemetry is most frequently utilized for tracking which category of aquatic animals?
(A) Benthic invertebrates
(B) Small forage fishes
(C) Large pelagic species
(D) Deep-sea demersal fishes

2004
43. Which legal framework provides the international basis for Monitoring, Control, and Surveillance in exclusive economic zones?
(A) UNCLOS
(B) Kyoto Protocol
(C) CITES
(D) Convention on Biological Diversity

2025
44. In the PCR cycle, what occurs during the denaturation step at 94-95 degrees Celsius?
(A) Primers anneal to template
(B) Polymerase synthesizes DNA
(C) DNA strands separate
(D) Nucleotides are degraded

2004
45. Which advantage makes metabarcoding superior to traditional barcoding for diet analysis in fishes?
(A) Individual species sequencing
(B) Processing intact organisms
(C) Simultaneous multi-taxa ID
(D) Avoidance of PCR methods

2012
46. Single Nucleotide Polymorphisms are preferred over microsatellites for certain population genetics studies due to what characteristic?
(A) High-throughput screening
(B) Higher mutation rates
(C) Longer repeat sequences
(D) Exclusive mitochondrial origin

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2013
47. A fish described using a trinomen (three-part name) represents which taxonomic level?
(A) Genus
(B) Species
(C) Subspecies
(D) Superfamily

2007
48. Standard length in finfish morphometrics is measured from the tip of the snout to which anatomical landmark?
(A) Tip of caudal fin
(B) Fork of caudal fin
(C) Base of caudal fin
(D) Edge of operculum

2007
49. Sympatric speciation implies that reproductive isolation occurs under which geographical condition?
(A) Absence of geographical barriers
(B) Complete physical separation
(C) Separation by a mountain range
(D) Separation by an ocean basin

2006

50. Match the teleost reproductive terms in List I with their definitions in List II.
List I: Reproductive Terms
P. Oogonia
Q. Vitellogenesis
R. Atresia
S. Spermiation
List II: Definitions
1. Yolk accumulation
2. Degeneration of oocytes
3. Release of mature sperm
4. Primordial germ cells
(A) P-4, Q-1, R-2, S-3
(B) P-1, Q-4, R-3, S-2
(C) P-4, Q-2, R-1, S-3
(D) P-2, Q-3, R-4, S-1

2025

51. The hectocotylus is a specialized reproductive arm found in males of which molluscan class?
(A) Gastropoda
(B) Bivalvia
(C) Cephalopoda
(D) Polyplacophora

2012

52. Maturation-inducing steroid in teleosts acts directly on the oocyte to trigger which final developmental event?
(A) Primary growth
(B) Cortical alveoli formation
(C) Germinal vesicle breakdown
(D) Vitellogenin uptake

2008

53. In male crustaceans, which hormone inhibits the development of female secondary sexual characteristics?
(A) Progesterone hormone
(B) Androgenic gland hormone
(C) Molt-inhibiting hormone
(D) Hyperglycemic hormone

2013

54. Determination of length at first maturity is crucial for defining which fishery management regulation?
(A) Maximum mesh size
(B) Minimum legal catch size
(C) Fishing season duration
(D) Total allowable catch

2010

55. A fish exhibiting a relative gut length less than 1.0 is most likely adapted to which diet?
(A) Planktonic algae
(B) Detritus
(C) Other fishes
(D) Macrophytes

2007

56. Organogenesis in fish embryos typically commences immediately after the completion of which stage?
(A) Cleavage
(B) Gastrulation
(C) Hatching
(D) Yolk sac absorption

2016

57. The spat stage is a settled, juvenile phase characteristic of the life cycle of which organism?
(A) Shrimp
(B) Crab
(C) Oyster
(D) Squid

2021

58. Which otolith pair is most commonly extracted for fish age determination due to its larger size?
(A) Lapillus
(B) Asteriscus
(C) Sagitta
(D) Statolith

2003

59. The parameter K in the von Bertalanffy growth equation represents what biological rate?
(A) Rate of natural mortality
(B) Rate of approach to L_∞
(C) Absolute growth in cm per year
(D) Instantaneous rate of weight gain

2018

60. Select the correct sequence of teleost early developmental stages.
(A) Morula → Blastula → Gastrula → Organogenesis
(B) Blastula → Morula → Gastrula → Organogenesis
(C) Gastrula → Morula → Blastula → Organogenesis
(D) Morula → Gastrula → Blastula → Organogenesis

2014

61. Yield-per-recruit models are primarily utilized to prevent which specific type of overfishing?
(A) Recruitment overfishing
(B) Growth overfishing
(C) Ecosystem overfishing

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(D) Economic overfishing

2025

62. Amphidromous fishes migrate between fresh and marine waters primarily for what purpose?
(A) Exclusively for spawning
(B) Feeding and growth
(C) Escape from predation
(D) Regulate temperature

2015

63. The primary hydraulic challenge addressed by fish ladders is the mitigation of what physical barrier?
(A) Low dissolved oxygen
(B) High water velocity
(C) Excessive turbidity
(D) Extreme temperature gradients

2023

64. External tagging methods, such as anchor tags, are most susceptible to which specific disadvantage?
(A) High tag shedding rates
(B) Immediate battery failure
(C) Internal tissue necrosis
(D) Disruption of PCR protocols

2017

65. Remote sensing detects ocean color variations to estimate the concentration of which marine component?
(A) Dissolved salts
(B) Phytoplankton
(C) Zooplankton
(D) Microplastics

2007

66. In fishery Surveillance, what is the primary role of at-sea observer programs?
(A) Marketing catch data
(B) Designing fishing gears
(C) Monitoring compliance and recording bycatch
(D) Constructing fish passes

2012

67. During DNA purification, ethanol or isopropanol is added to the solution to achieve what outcome?
(A) Dissolve lipids
(B) Precipitate DNA
(C) Denature proteins
(D) Stabilize RNA

2005

68. The COI gene is highly effective for barcoding because it exhibits what specific evolutionary property?
(A) High intraspecific variation and low interspecific variation
(B) Low intraspecific variation and high interspecific variation
(C) Zero mutation rate
(D) Frequent genomic recombination

2014

69. Genetic stock identification is vital for fisheries management because it determines what population attribute?
(A) Total biomass
(B) Reproductive isolation among spatial units
(C) Daily food consumption
(D) Age at first maturity

2010

70. Arrange the following PCR steps in the correct operational sequence, then select the matching option.
I. Extension
II. Initial Denaturation
III. Annealing
IV. Denaturation
(A) II → IV → III → I
(B) II → III → IV → I
(C) IV → II → III → I
(D) III → IV → I → II

2022

71. In finfish nomenclature, the suffix "-idae" denotes which taxonomic rank?
(A) Family
(B) Suborder
(C) Subfamily
(D) Genus

2006

72. Which morphometric measurement quantifies the vertical distance at the deepest part of a fish's body?
(A) Pre-dorsal length
(B) Snout length
(C) Body depth
(D) Caudal peduncle depth

2022

73. A monophyletic group in fish phylogeny is defined as containing which components?
(A) An ancestor and all its descendants
(B) An ancestor and some of its descendants
(C) Descendants from multiple ancestors

NODIA

(D) Only extant species

2014

74. The process by which spermatogonia transform into functional spermatozoa is termed what?
(A) Spermiogenesis
(B) Oogenesis
(C) Vitellogenesis
(D) Atresia

2002

75. In female crustaceans, the ovary exhibits which distinct macroscopic change during advanced maturation?
(A) It becomes entirely transparent
(B) It expands and develops prominent coloration
(C) It shrinks to microscopic size
(D) It detaches from the hepatopancreas

2015

76. Dopamine exerts what specific regulatory effect on the HPG axis in many teleost species?
(A) Stimulates GnRH release
(B) Inhibits gonadotropin release
(C) Enhances testosterone production
(D) Promotes oocyte hydration

2011

77. The X-organ-sinus gland complex in crustaceans is anatomically located in which structure?
(A) Hepatopancreas
(B) Thoracic ganglion
(C) Eyestalk
(D) Antennal gland

2014

78. Which mathematical expression accurately describes relative fecundity?
(A) Absolute fecundity divided by ovary weight
(B) Gonad weight divided by somatic weight
(C) Absolute fecundity divided by total body weight
(D) Number of spawned eggs divided by time

2011

79. Omnivorous fishes typically display a relative gut length that falls within which general range?
(A) Less than 0.5
(B) Between 1.0 and 3.0
(C) Greater than 5.0
(D) Greater than 10.0

2010

80. Consider the following statements regarding crustacean larval stages:
I. Nauplius has three pairs of appendages.
II. Zoea is characterized by compound eyes.
III. Mysis strictly lacks functional walking legs.
Which of the above statement(s) is/are INCORRECT?
(A) I and II
(B) II and III
(C) I and III
(D) III only

2022

81. The transition from a bilaterally symmetrical larva to an asymmetrical adult characterizes the metamorphosis of which fish order?
(A) Pleuronectiformes
(B) Clupeiformes
(C) Salmoniformes
(D) Cypriniformes

2016

82. Which non-lethal ageing technique utilizes structures that can be removed without sacrificing the fish?
(A) Scale reading
(B) Otolith analysis
(C) Vertebrae sectioning
(D) Cleithrum extraction

2024

83. The length-weight relationship equation is expressed as $W = aL^b$. What does parameter ' a ' signify?
(A) Condition factor intercept
(B) Allometric growth coefficient
(C) Maximum weight
(D) Asymptotic length

2006

84. Catch curve analysis is a standard methodology for estimating which population parameter?
(A) Natural mortality
(B) Total mortality
(C) Recruitment rate
(D) Growth coefficient

2019

85. The point at which a growing cohort achieves its highest collective biomass is referred to as what?
(A) Maximum Sustainable Yield
(B) Critical age
(C) Length at first maturity
(D) Asymptotic weight

2019

86. Which term describes the downstream migration of juvenile catadromous fishes, such as eels?
(A) Elver migration
(B) Smoltification

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(C) Kelting
(D) Spawning run

2012

87. A vertical slot fishway is advantageous over a pool and weir design due to what functional capability?
(A) It functions efficiently under fluctuating water levels
(B) It requires zero water flow
(C) It physically transports fish via an elevator mechanism
(D) It only allows downstream migration

2024

88. Fin clipping is considered which category of fish marking?
(A) Chemical marking
(B) Mutilation marking
(C) Internal tagging
(D) Electronic tagging

2010

89. In PFZ forecasting, thermal fronts are identified because they typically indicate areas of what oceanic phenomenon?
(A) Upwelling
(B) Downwelling
(C) Hypoxia
(D) Salinity stratification

2013

90. The following question consists of two statements, one labelled as Assertion (A) and the other labelled as Reason (R).
Assertion (A): Real-time Vessel Monitoring Systems (VMS) rely entirely on acoustic signals to track fleets globally.
Reason (R): VMS typically uses satellite-based communication and Global Positioning System (GPS) to track vessel locations.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2007

91. During the annealing phase of PCR, the temperature is typically lowered to what range to allow primer binding?
(A) 50-65 degrees Celsius
(B) 94-98 degrees Celsius
(C) 72-75 degrees Celsius
(D) 10-20 degrees Celsius

2019

92. Why is the mitochondrial genome preferred over the nuclear genome for standard DNA barcoding?
(A) It lacks introns and has a high copy number per cell
(B) It exhibits biparental inheritance
(C) It has an extremely low mutation rate
(D) It contains microsatellite repeats

2006

93. When determining population genetic structure, what does a high $F_{\{ST\}}$ value indicate about the populations?
(A) Significant genetic differentiation
(B) High gene flow between them
(C) Complete panmixia
(D) Inbreeding depression

NODIA

2008

94. The rule of priority in zoological nomenclature does not apply to names published prior to which year?
(A) 1758
(B) 1859
(C) 1901
(D) 1999

2004

95. Counting the number of gill rakers on the first branchial arch is an example of identifying which type of character?
(A) Meristic
(B) Morphometric
(C) Karyotypic
(D) Behavioral

2014

96. Cladistics classifies aquatic organisms based strictly on which type of evolutionary traits?
(A) Shared derived characters (synapomorphies)
(B) Shared primitive characters (symplesiomorphies)
(C) Analogous characters
(D) Morphometric averages

2010

97. The micropyle in a teleost egg serves what essential reproductive function?
(A) Sperm entry
(B) Waste excretion
(C) Gas exchange
(D) Yolk absorption

2004

98. In male penaeid shrimps, the petasma is a modified structure on which paired appendages?

(A) First pleopods
(B) Second pleopods
(C) Uropods
(D) Pereiopods

2002
99. Which pituitary cell type is responsible for synthesizing and releasing gonadotropins in fishes?
(A) Gonadotrophs
(B) Somatotrophs
(C) Lactotrophs
(D) Thyrotrophs

2008
100. Match the crustacean or mollusc neuroendocrine organs in List I with their primary functions in List II.
List I: Neuroendocrine Organs
P. Y-organ
Q. X-organ
R. Optic gland
S. Androgenic gland
List II: Primary Functions
1. Controls male differentiation in crustaceans
2. Produces molt-inhibiting hormone
3. Secretes ecdysteroids for molting
4. Regulates cephalopod reproduction
(A) P-3, Q-2, R-4, S-1
(B) P-2, Q-3, R-1, S-4
(C) P-4, Q-1, R-3, S-2
(D) P-3, Q-4, R-2, S-1

2005
101. An organism reaches length at first maturity when what percentage of the population is sexually mature?
(A) 10%
(B) 50%
(C) 90%
(D) 100%

2019
102. Which feeding index evaluates the preference of a predator for specific prey items available in the environment?
(A) Electivity Index
(B) Gastrosomatic Index
(C) Condition Factor
(D) Gonadosomatic Index

2004
103. The hatching gland in fish embryos secretes enzymes primarily to degrade which protective structure?
(A) Chorion
(B) Yolk sac
(C) Blastoderm
(D) Notochord

2019
104. Which developmental stage in bivalve molluscs immediately precedes the settlement of the spat?
(A) Pediveliger
(B) Trochophore
(C) D-shaped larva
(D) Nauplius

2009
105. Daily growth increments in fish otoliths are composed of alternating protein matrices and which mineral?
(A) Calcium carbonate
(B) Calcium phosphate
(C) Silica
(D) Magnesium sulfate

2002
106. In fish growth modeling, the parameter t_0 mathematically represents what concept?
(A) The age at which the fish reaches maturity
(B) The hypothetical age when the fish's length is zero
(C) The time required to double in weight
(D) The lifespan of the species

2014
107. Which empirical formula is frequently used to estimate Natural Mortality based on von Bertalanffy parameters and temperature?
(A) Pauly's empirical equation
(B) Schaefer's model
(C) Fox's model
(D) Gulland's formula

2008
108. In the context of yield-per-recruit models, $F_{\{}\max_{\}}$ indicates the fishing mortality rate that maximizes what metric?
(A) Yield per individual recruit
(B) Spawning stock biomass
(C) Total ecosystem productivity
(D) Economic profit per vessel

2008
109. Which physiological change triggers the smoltification process in anadrom--ous salmonids?
(A) Increased cortisol and growth hormone
(B) Decreased thyroid hormone levels
(C) Suppression of gill Na+/K+-ATPase
(D) Loss of silver coloration

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2013

110. Consider the following statements regarding fish migration:

I. Anadromous fishes spawn in freshwater.
II. Catadromous fishes spawn in freshwater.
III. Amphidromous fishes migrate purely for feeding.

Which of the above statement(s) is/are correct?

(A) I and II
(B) I and III
(C) II and III
(D) I only

2024

111. Denil fishways are distinct from vertical slot fishways primarily because they incorporate which structural element?

(A) U-shaped or V-shaped baffles on the floor and walls
(B) Mechanized hydraulic lifts
(C) Deep resting pools at every one-meter interval
(D) Complete darkness to simulate deep water

2017

112. Acoustic tags rely on which principle to determine a fish's position using a receiver array?

(A) Triangulation of sound pulses
(B) Magnetic field variations
(C) Passive RFID scanning
(D) Visual light emission

2006

113. Synthetic Aperture Radar (SAR) is utilized in fisheries remote sensing primarily to detect what ocean feature?

(A) Sea surface roughness and vessels
(B) Deep ocean currents
(C) Salinity profiles
(D) Benthic flora density

2024

114. In fishery MCS operations, what does a logbook precisely record?

(A) Daily catch and effort data
(B) Vessel maintenance schedules
(C) Market prices of fish
(D) Genetic barcoding results

2015

115. Taq polymerase is highly suited for PCR because it possesses which critical biochemical property?

(A) It is thermostable and resists denaturation
(B) It functions at freezing temperatures
(C) It is a reverse transcriptase
(D) It degrades RNA efficiently

2010

116. Which specific region of the Cytochrome c oxidase subunit I gene is typically targeted for animal DNA barcoding?

(A) 100 bp segment at the 3' end
(B) 648 bp segment at the 5' end
(C) 15,000 bp whole mitochondria
(D) 1000 bp variable D-loop area

2015

117. What distinguishes single nucleotide polymorphisms (SNPs) from microsatellites as genetic markers?

(A) SNPs are biallelic whereas microsatellites are multiallelic
(B) SNPs have higher mutation rates
(C) SNPs are only found in mitochondria
(D) SNPs involve large tandem repeats

NODIA

2017

118. Which principle states that a zoological name is invalid if it has already been used for another taxon?

(A) Principle of Homonymy
(B) Principle of Priority
(C) Principle of Typification
(D) Principle of Coordination

2015

119. A meristic character such as the number of fin rays is advantageous in taxonomy because it possesses which trait?

(A) It remains constant regardless of body size
(B) It fluctuates drastically with seasonal temperature
(C) It requires live fish for counting
(D) It only applies to larval stages

2001

120. Consider the following statements concerning evolutionary biology in fishes:

I. Cladograms depict branching evolutionary relationships.
II. A paraphyletic group includes all descendants of an ancestor.
III. Homologous structures imply shared ancestry.
IV. Analogous structures arise from convergent evolution.

Which of the above statement(s) is/are INCORRECT?

(A) I and III
(B) II only
(C) III and IV
(D) II and IV

2024

121. In teleost gametogenesis, primary spermatocytes undergo which cellular division to become secondary spermatocytes?
(A) First meiotic division
(B) Mitosis
(C) Second meiotic division
(D) Binary fission

2009

122. Thelycum in female penaeid shrimps functions primarily as what type of organ?
(A) Sperm receptacle
(B) Egg extrusion pore
(C) Digestive gland
(D) Excretory opening

2010

123. Gonadotropin I (FSH-like hormone) in teleosts is primarily involved in stimulating which reproductive phase?
(A) Vitellogenesis and early spermatogenesis
(B) Final oocyte maturation
(C) Ovulation
(D) Spawning behavior

2024

124. Which neurohormone acts as the major gonadotropin-releasing factor in decapod crustaceans?
(A) Gonad-stimulating hormone
(B) Methyl farnesoate
(C) Red pigment-concentrating hormone
(D) Serotonin

2001

125. The ratio of absolute fecundity to the somatic weight of a fish defines which reproductive index?
(A) Relative fecundity
(B) Gonadosomatic Index
(C) Ponderal Index
(D) Condition Factor

2012

126. A fish species displaying a short, straight intestine and well-developed canine teeth is most likely what?
(A) Carnivorous
(B) Herbivorous
(C) Detritivorous
(D) Planktivorous

2003

127. Which specific embryonic structure in fish develops into the central nervous system?
(A) Neural tube
(B) Endoderm
(C) Somites
(D) Notochord

2014

128. Megalopa is an advanced larval stage characteristically found in the life cycle of which crustacean?
(A) Brachyuran crab
(B) Penaeid shrimp
(C) Barnacle
(D) Copepod

2011

129. When reading fish scales, "false annuli" can lead to age overestimation. What typically causes false annuli?
(A) Summer spawning or sudden environmental stress
(B) Regular winter starvation
(C) Isometric growth phases
(D) Excessive food availability

2016

130. Consider the following statements concerning the length-weight relationship exponent 'b':
I. When $b = 3$, growth is isometric.
II. When $b > 3$, growth is positive allometric.
III. When $b < 3$, the fish becomes leaner as it grows.
IV. b is entirely unaffected by the fish's sex.
V. b is an indicator of condition.
Which of the above statement(s) is/are correct?
(A) I, II, III and V
(B) I, II, IV and V
(C) I, III, IV and V
(D) II, III, IV and V

2002

131. The instantaneous rate of total mortality (Z) is mathematically derived from the negative slope of which plot?
(A) Catch curve
(B) Length-weight curve
(C) von Bertalanffy growth curve
(D) Stock-recruitment curve

2014

132. In the Beverton-Holt stock-recruitment model, the curve approaches a horizontal asymptote due to which density-dependent factor?
(A) Habitat carrying capacity limitations
(B) Adult cannibalism on juveniles
(C) Allee effect at low densities
(D) Interspecific competition only

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2022

133. Which term refers to the vertical movement of fish in the water column synchronized with light patterns?
(A) Diel vertical migration
(B) Latitudinal migration
(C) Ontogenetic migration
(D) Longitudinal migration

2004

134. Which hydraulic parameter is most critical to control in a fish pass to ensure successful upstream traversal by target species?
(A) Water velocity
(B) Total volume capacity
(C) Dissolved oxygen saturation
(D) Channel width

2001

135. The primary limitation of using chemical marking, such as oxytetracycline, in fisheries is what?
(A) It requires the sacrifice of the fish to detect the mark
(B) It alters the external coloration of the fish
(C) It destroys the internal organs rapidly
(D) It causes immediate genetic mutations

2002

136. In India, PFZ advisories are generated and disseminated primarily by which national agency?
(A) INCOIS
(B) ICAR-CMFRI
(C) FSI
(D) MPEDA

2010

137. Which tool provides spatial enforcement capability by comparing authorized vessel positions with radar contacts?
(A) Vessel Monitoring System (VMS)
(B) Catch certificates
(C) Quota monitoring algorithms
(D) Market state inspections

2001

138. The use of EDTA in DNA extraction buffers serves what specific biochemical purpose?
(A) Chelation of divalent cations to inhibit nucleases
(B) Lysis of nuclear membranes
(C) Precipitation of proteins
(D) Solubilization of lipids

2003

139. Environmental DNA (eDNA) metabarcoding identifies species presence by amplifying DNA from which source?
(A) Water or sediment samples
(B) Tissue biopsies of live fish
(C) Preserved museum specimens
(D) Purified gametes

2018

140. The following question consists of two statements, one labelled as Assertion (A) and the other labelled as Reason (R).
Assertion (A): Microsatellite markers are highly effective for assigning individuals to specific parental lineages.
Reason (R): Microsatellites are highly polymorphic, co-dominant markers with rapid mutation rates.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2004

141. The valid scientific name of the Indian oil sardine is correctly written as what?
(A) Sardinella longiceps
(B) Sardinella Longiceps
(C) sardinella longiceps
(D) Sardinella LONGICEPS

2022

142. The number of vertebrae in a fish is determined by genetics and which environmental factor during early development?
(A) Temperature
(B) Salinity
(C) Photoperiod
(D) Turbidity

2013

143. Which evolutionary concept explains the origin of completely distinct species without geographical separation?
(A) Sympatric speciation
(B) Allopatric speciation
(C) Peripatric speciation
(D) Vicariance

2023

144. In a teleost egg, the cortical reaction occurs immediately after fertilization to serve what purpose?

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(A) Block polyspermy
(B) Initiate cleavage
(C) Dissolve the chorion
(D) Synthesize yolk

2008

145. In bivalve anatomy, the gonads are typically interspersed within the tissues of which other major organ system?
(A) Mantle or visceral mass
(B) Gills
(C) Adductor muscle
(D) Siphons

2008

146. Which steroid hormone is the primary active androgen in male teleost fishes?
(A) 11-ketotestosterone
(B) Testosterone
(C) Estradiol-17beta
(D) Progesterone

2011

147. What surgical technique is commonly utilized in aquaculture to induce rapid spawning in penaeid shrimps?
(A) Unilateral eyestalk ablation
(B) Fin clipping
(C) Hypophysectomy
(D) Gonadectomy

2013

148. The peak of the Gonadosomatic Index curve temporally correlates with which phase of fish life history?
(A) Active spawning
(B) Larval settlement
(C) Winter dormancy
(D) Smoltification

2017

149. Herbivorous fishes generally possess specialized digestive structures, such as a highly muscular stomach, often called what?
(A) Gizzard
(B) Pyloric caeca
(C) Spiral valve
(D) Crystalline style

2006

150. Match the fish early life history terms in List I with their correct definitions in List II.
List I: Life History Terms
P. Yolk sac larva
Q. Flexion
R. Metamorphosis
S. Fry
List II: Definitions
1. Upward bending of the notochord
2. Larva relying entirely on endogenous nutrition
3. Fully scaled juvenile capable of independent feeding
4. Transition from larval to juvenile traits
(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-4, Q-3, R-2, S-1
(D) P-3, Q-1, R-4, S-2

NODIA

2018

151. Which larval stage of bivalve molluscs is characterized by the presence of a D-shaped shell?
(A) Straight-hinge veliger
(B) Trochophore
(C) Pediveliger
(D) Spat

2013

152. In older, long-lived fishes, which hard structure is preferred for ageing due to its resistance to resorption?
(A) Otoliths
(B) Scales
(C) Fin rays
(D) Scutes

2008

153. A Ford-Walford plot is a graphical method used to estimate which two parameters of the von Bertalanffy equation?
(A) K and L_∞
(B) Z and M
(C) a and b
(D) F and E

2022

154. Which parameter is defined as the ratio of fishing mortality (F) to total mortality (Z)?
(A) Exploitation rate
(B) Survival rate
(C) Condition factor
(D) Instantaneous growth rate

2014

155. Recruitment overfishing occurs when fishing activity severely depletes which segment of the population?
(A) Spawning stock biomass
(B) Pre-recruits
(C) Senescent individuals
(D) Zooplankton prey

2018

156. The European eel exhibits an extreme form of which migration pattern by traveling from freshwater to the Sargasso Sea to spawn?
(A) Catadromous
(B) Anadromous
(C) Oceanodromous
(D) Potamodromous

2025

157. A pool and weir fishway requires fish to ascend by exhibiting which specific swimming behavior?
(A) Sustained burst swimming and jumping
(B) Passive drifting
(C) Benthic crawling
(D) Burrowing

2011

158. Passive Integrated Transponder (PIT) tags do not require internal batteries because they are powered by what?
(A) Electromagnetic field of the reader
(B) Solar radiation
(C) Water pressure
(D) The fish's body heat

2001

159. Altimetry data from satellites is utilized in fisheries oceanography primarily to detect which physical feature?
(A) Sea surface height anomalies and mesoscale eddies
(B) Phytoplankton blooms
(C) Bottom topography mapping
(D) Coral reef bleaching

2005

160. Consider the following larval stages in the life cycle of a typical penaeid shrimp:
I. Mysis
II. Zoea
III. Nauplius
IV. Postlarva
Which of the following represents the correct sequence of development?
(A) III → II → I → IV
(B) III → I → II → IV
(C) II → III → I → IV
(D) I → II → III → IV

2004

161. In PCR, oligonucleotide primers dictate the specificity of the reaction by binding to what?
(A) Flanking regions of the target DNA
(B) RNA polymerase
(C) Restriction enzyme cut sites
(D) Exon-intron boundaries only

2007

162. DNA barcoding is highly effective for identifying processed fish products primarily because of what characteristic?
(A) DNA remains stable even after minor processing or freezing
(B) It requires morphologically intact specimens
(C) Processed fish contain more mitochondrial DNA
(D) Barcoding algorithms ignore degraded sequences

2009

163. The Hardy-Weinberg equilibrium is a foundational concept used when analyzing microsatellite data to detect what?
(A) Deviations indicating selection, migration, or non-random mating
(B) Absolute population biomass
(C) Daily growth increments
(D) Trophic level positioning

2022

164. The suffix "-oidea" in ichthyotaxonomy is strictly reserved for which taxonomic rank?
(A) Superfamily
(B) Order
(C) Suborder
(D) Tribe

2017

165. Morphometric analyses often require standardizing measurements to account for which confounding biological variable?
(A) Body size (allometry)
(B) Age
(C) Sex
(D) Diet

2016

166. Polyploidy, leading to sympatric speciation, is most frequently observed naturally in which group of fishes?
(A) Sturgeons and some cyprinids
(B) Sharks
(C) Tunas
(D) Eels

2008

167. Histological examination of a teleost ovary in the late vitellogenic stage will primarily reveal oocytes packed with what?
(A) Dense yolk granules
(B) Tiny cortical alveoli

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(C) Multiple nucleoli
(D) Empty follicles

2005

168. In male cephalopods, spermatophores are complex structures specialized for what specific reproductive function?
(A) Safe transfer of sperm to the female
(B) Asexual reproduction
(C) Nutrient storage
(D) Digestion of prey

2008

169. Vitellogenesis in female teleosts is directly stimulated by which hormone released from the ovarian follicles?
(A) Estradiol-17beta
(B) Testosterone
(C) Cortisol
(D) Somatostatin

2011

170. Consider the following hormones and events involved in the crustacean molting process:
I. Molt-inhibiting hormone drops
II. Y-organ secretes ecdysone
III. Environmental trigger
IV. Ecdysone converts to active 20-hydroxyecdysone
Which of the following represents the correct sequence from primary signal to final execution?
(A) III → I → II → IV
(B) I → III → II → IV
(C) III → II → I → IV
(D) I → II → III → IV

2021

171. The fecundity of a fish generally exhibits a mathematical relationship with body length that is what?
(A) Exponential or power functional
(B) Inversely proportional
(C) Linear
(D) Completely random

2021

172. The presence of numerous, elongated pyloric caeca is anatomically linked to increasing surface area for what process?
(A) Secretion of digestive enzymes and nutrient absorption
(B) Respiration
(C) Buoyancy control
(D) Osmoregulation

2014

173. The embryonic shield in teleost development is the primary site of formation for what embryonic axis?
(A) Anterior-posterior
(B) Dorsal-ventral
(C) Left-right
(D) Animal-vegetal

2024

174. Which specialized appendage do barnacle nauplii use for both swimming and capturing food?
(A) Antennae
(B) Maxillipeds
(C) Uropods
(D) Pleopods

2001

175. The formation of translucent and opaque zones on otoliths corresponds directly to seasonal variations in what?
(A) Somatic growth rate
(B) Predation pressure
(C) Salinity
(D) Lunar cycles

2011

176. Which method relies on tracking the progression of size groups over time to estimate fish growth parameters?
(A) Length-frequency analysis (e.g., ELEFAN)
(B) Mark-recapture
(C) Otolith sectioning
(D) Scale reading

2015

177. If the exploitation rate (E) exceeds 0.5 in a heavily fished stock, what is the standard theoretical conclusion?
(A) The stock is likely overexploited
(B) The stock is underexploited
(C) The stock is optimally exploited
(D) The stock is experiencing zero natural mortality

NODIA

2002

178. Consider the following statements regarding yield-per-recruit estimations:
I. They evaluate the yield from a single cohort over its lifespan.
II. They calculate MSY in absolute biomass terms.
III. They assume constant recruitment independent of stock size.
IV. They help determine optimal age at first capture.

Which of the above statement(s) is/are INCORRECT?
(A) I and III
(B) II only
(C) III and IV
(D) I and IV

2004

179. Homing behavior in migratory salmonids returning to natal streams is primarily guided by which sensory mechanism?
(A) Olfactory imprinting
(B) Vision
(C) Electroreception
(D) Lateral line mechanoreception

2007

180. The following question consists of two statements, one labelled as Assertion (A) and the other labelled as Reason (R).
Assertion (A): Vertical slot fishways accommodate a wide variety of fish sizes and species.
Reason (R): The vertical slot design provides a continuous flow depth, allowing fish to choose their preferred swimming depth.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2007

181. What is the primary operational advantage of acoustic telemetry over standard archival tags for tracking fish?
(A) Acoustic telemetry allows real-time or remote tracking without recapturing the fish
(B) Acoustic tags do not require batteries
(C) Acoustic tags are significantly cheaper
(D) Acoustic telemetry works best in highly turbulent rivers

2012

182. Geographic Information Systems (GIS) applied to fisheries management fundamentally depend on what type of data?
(A) Spatially referenced data
(B) Strictly textual logbook data
(C) Purely genetic data
(D) Nominal economic data

2025

183. Port State Measures (PSMA) form a critical international MCS agreement primarily designed to prevent what activity?
(A) Illegal, Unreported, and Unregulated (IUU) fishing
(B) Marine pollution
(C) Coral reef degradation
(D) Aquaculture expansion

2004

184. In spectrophotometric quantification of isolated DNA, a $\frac{260}{280}$ nm absorbance ratio of 1.8 indicates what?
(A) High purity DNA
(B) RNA contamination
(C) Protein contamination
(D) Completely degraded DNA

2005

185. DNA barcoding relies on the presence of a "barcode gap." What defines this gap?
(A) Interspecific genetic distances being significantly larger than intraspecific distances
(B) The physical separation between nuclear and mitochondrial genomes
(C) High intraspecific divergence and low interspecific divergence
(D) Missing sequence data in the COI gene

2002

186. Which statistical method is commonly utilized to visualize population genetic structure using microsatellite allele frequencies?
(A) Principal Component Analysis (PCA)
(B) Linear Regression
(C) ANOVA
(D) Chi-square goodness of fit

2022

187. The holotype is legally defined in biological taxonomy as what?
(A) The single physical specimen designated to represent a new species
(B) Any specimen of a species
(C) A secondary specimen collected later
(D) The textual description of the species

2009

188. Meristic counts of lateral line scales typically start from the operculum and end at which structural landmark?
(A) Hypural plate or structural base of the caudal fin
(B) Tip of the caudal fin
(C) Base of the dorsal fin
(D) Anal opening

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2013

189. A molecular clock approach in fish phylogeny estimates evolutionary divergence time based on what metric?
(A) Rate of nucleotide sequence mutation
(B) Rate of morphometric change
(C) Frequency of fossil discoveries
(D) Changes in feeding habits

2004

190. The following question consists of two statements, one labelled as Assertion (A) and the other labelled as Reason (R).
Assertion (A): Teleosts with synchronous ovarian development typically spawn only once per lifetime or once per season.
Reason (R): Synchronous ovaries contain multiple groups of oocytes at various distinct stages of development simultaneously.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2006

191. In penaeid shrimps, what is the primary function of the spermatophore?
(A) Encapsulating and protecting sperm during transfer
(B) Stimulating molting
(C) Digesting food
(D) Producing hormones

2002

192. Which environmental factor is generally the primary cue for initiating the HPG neuroendocrine cascade in temperate fishes?
(A) Photoperiod and temperature changes
(B) Salinity changes
(C) Turbidity levels
(D) Atmospheric pressure

2016

193. The crustacean hyperglycemic hormone (CHH) family of peptides, produced in the eyestalk, is most directly responsible for regulating what?
(A) Blood glucose levels and repressing reproduction
(B) Oxygen transport
(C) Exoskeleton calcification
(D) Muscle contraction

2005

2021

194. The determination of length at first maturity ($L_{\{50\}}$) involves plotting length classes against what variable?
(A) Percentage of mature individuals
(B) Gonad weight
(C) Absolute fecundity
(D) Otolith ring counts

2014

195. A fish exhibiting terminal mouth position and short gill rakers is anatomically adapted for which feeding strategy?
(A) Capturing large discrete prey items
(B) Filter feeding on phytoplankton
(C) Scraping algae from rocks
(D) Sifting mud for detritus

2010

196. During teleost embryogenesis, the formation of the blastoderm involves cellular divisions predominantly confined to which area?
(A) The animal pole
(B) The entire yolk mass
(C) The vegetal pole
(D) The chorionic space

NODIA

2018

197. Which of the following is a primary characteristic distinguishing a zoea larva from a mysis larva in shrimps?
(A) Appendage type used for swimming
(B) Presence of sessile compound eyes
(C) Development of functional chelae
(D) Vertical position in water column

2009

198. Why is sectioning of otoliths often required for ageing long-lived, slow-growing fishes?
(A) Growth at the margins becomes too compressed to read on whole otoliths
(B) Whole otoliths become transparent with age
(C) Daily rings overwrite annual rings
(D) Otoliths dissolve internally over time

2009

199. The asymptotic length (L_∞) in the von Bertalanffy growth model mathematically represents what?
(A) The theoretical maximum length a fish would reach if it lived indefinitely
(B) The length at hatching
(C) The length at first maturity
(D) The optimal harvest length

2005

200. Match the mortality parameters in List I with their correct estimation methods in List II.

List I: Mortality Parameters

P. Total Mortality (Z)

Q. Natural Mortality (M)

R. Fishing Mortality (F)

S. Exploitation Rate (E)

List II: Estimation Methods

1. Subtraction of M from Z
2. Pauly's empirical formula
3. Ratio of F to Z
4. Length-converted catch curve

(A) P-4, Q-2, R-1, S-3

(B) P-2, Q-4, R-3, S-1

(C) P-4, Q-1, R-2, S-3

(D) P-1, Q-2, R-4, S-3

2004

201. Which parameter dictates the steepness of the initial slope in a Beverton-Holt stock-recruitment curve?

(A) Density-independent juvenile survival rate

(B) Carrying capacity

(C) Maximum recruitment

(D) Age of first capture

2014

202. Diadromy is a general classification that includes which specific migration patterns?

(A) Anadromous, catadromous, and amphidromous

(B) Oceanodromous and potamodromous

(C) Diel vertical migrations only

(D) Latitudinal oceanic migrations only

2001

203. A fish pass designed with an inclined channel containing densely packed bristles is known as what type of fishway?

(A) Brush fishway

(B) Vertical slot

(C) Denil

(D) Fish lock

2016

204. Which tagging method allows researchers to reconstruct the exact geographic path a marine fish took over several months?

(A) Pop-up satellite archival tags (PSATs)

(B) Coded wire tags

(C) T-bar anchor tags

(D) Fin clipping

2002

205. In GIS mapping for Potential Fishing Zones, chlorophyll-a concentration is used primarily as a proxy for what biological factor?

(A) Primary productivity and potential prey abundance

(B) Salinity stratification

(C) Heavy metal pollution

(D) Spawning habitat suitability

2008

206. Which technological tool strictly belongs to the "Surveillance" component of fisheries MCS?

(A) Patrol vessels and aerial reconnaissance

(B) Designing national fisheries legislation

(C) Establishing quota limits

(D) Processing factory sanitation checks

2009

207. During standard DNA purification, what is the role of a buffer containing Tris-HCl?

(A) Maintaining a stable pH environment

(B) Cell lysis

(C) Breaking disulfide bonds

(D) Precipitating DNA

2006

208. High-throughput sequencing used in metabarcoding bypasses the need for which traditional barcoding step?

(A) Sequencing of individual amplicons

(B) Standard DNA extraction protocols

(C) Complex bioinformatics analysis

(D) Polymerase chain reaction steps

2019

209. Population genetic structure studies use selectively neutral markers like microsatellites to trace what historical phenomenon?

(A) Evolutionary gene flow and genetic drift

(B) Immediate phenotypic adaptation

(C) Dietary shifts over a single season

(D) Acclimation to warming waters

2001

210. Consider the following statements concerning the International Code of Zoological Nomenclature:

I. It enforces the binomial system.

II. It allows duplicate generic names within zoology.

III. It resolves homonymy through the principle of priority.

Which of the above statement(s) is/are correct?

(A) I and III

(B) I and II

(C) II and III

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(D) III only

2003

211. Which morphometric tool captures body shape variation by analyzing the geometric relationships of fixed anatomical landmarks?
(A) Traditional linear morphometrics
(B) Geometric morphometrics
(C) Meristic counting
(D) Electrophoresis

2003

212. Which evolutionary mechanism involves the rapid diversification of a single ancestral lineage into multiple species filling different ecological niches?
(A) Adaptive radiation
(B) Natural selection
(C) Stabilizing drift
(D) Bottleneck effect

2008

213. Post-ovulatory follicles in a fish ovary are primary histological indicators of what specific reproductive event?
(A) Recent spawning
(B) Imminent vitellogenesis
(C) Oocyte atresia
(D) Hermaphroditism

2016

214. The pen in cephalopods (e.g., squids) is an internal vestigial structure evolutionarily derived from what?
(A) The external molluscan shell
(B) The radula
(C) The crystalline style
(D) The beak

2022

215. In the teleost brain, neurons producing GnRH project directly to which specific region of the pituitary?
(A) Pars distalis
(B) Neurohypophysis
(C) Pars intermedia
(D) Saccus vasculosus

2013

216. The mandibular organ in crustaceans produces which hormone that regulates reproduction and molting?
(A) Methyl farnesoate
(B) Ecdysone
(C) Gonad-inhibiting hormone
(D) Corazonin

2003

217. Fecundity estimates must be conducted prior to which physiological reproductive event to ensure accuracy?
(A) Hydration and ovulation
(B) Vitellogenesis
(C) Maturation
(D) Cortical alveoli stage

2021

218. The Index of Preponderance is a feeding index that fundamentally combines which two dietary metrics?
(A) Volume and frequency of occurrence
(B) Weight and caloric value
(C) Number of prey and predator length
(D) Digestion rate and gastric evacuation

2001

219. During fish embryonic development, the formation of the somites marks the beginning of which major developmental phase?
(A) Organogenesis
(B) Cleavage
(C) Blastulation
(D) Gastrulation

2022

220. Consider the following statements regarding crustacean metamorphosis:
I. Nauplii molt multiple times.
II. Zoeae use pleopods for swimming.
III. Megalopa is a transitional post-larval phase.
IV. Metamorphosis is regulated solely by water temperature.
Which of the above statement(s) is/are correct?
(A) I and III
(B) I, II and III
(C) II and IV
(D) I, III and IV

NODIA

2014

221. Which specific preparation technique is required to read daily growth increments on larval fish otoliths?
(A) Grinding and polishing the sagittal plane
(B) Boiling in sodium hydroxide
(C) Staining with alizarin red whole-mount
(D) Burning and breaking

2004

222. The length-weight relationship is logarithmic. What statistical technique is used to estimate parameters 'a' and 'b' from transformed data?
(A) Linear regression
(B) Logistic regression

(C) Chi-square analysis
(D) Moving average

2003
223. Natural mortality (M) in fish populations typically exhibits what relationship with the fish's asymptotic length (L_∞)?
(A) Negative correlation
(B) Positive correlation
(C) Exponential increase
(D) No correlation

2025
224. Which population dynamics model specifically assumes that the rate of recruitment decline at high stock levels is exponential due to cannibalism?
(A) Ricker model
(B) Beverton-Holt model
(C) Schaefer model
(D) Fox model

2022
225. Which behavior involves a daily migration of marine organisms from the mesopelagic zone to the epipelagic zone at dusk?
(A) Diel vertical migration
(B) Ontogenetic migration
(C) Spawning migration
(D) Longitudinal migration

2024
226. To accommodate small, weak-swimming fish, a fishway must primarily minimize which hydraulic factor?
(A) Turbulence and velocity
(B) Depth of water column
(C) Total time of transit
(D) Width of the entrance

2018
227. Chemical marking with Alizarin Red S permanently stains which specific tissue in fish?
(A) Calcified structures like otoliths and scales
(B) Adipose tissue
(C) Liver parenchyma
(D) Retinal cells

2024
228. In satellite remote sensing for PFZ, upwelling zones are characterized by which combination of signals?
(A) Low SST and high chlorophyll
(B) High SST and low chlorophyll
(C) High SST and high chlorophyll
(D) Low SST and low chlorophyll

2025
229. Which MCS activity is primarily a "Control" mechanism rather than "Monitoring" or "Surveillance"?
(A) Enacting licensing frameworks and gear regulations
(B) Utilizing VMS trackers
(C) Conducting aerial patrols
(D) Inspecting catches at port

2007
230. Consider the following statements regarding PCR components:
I. dNTPs provide the building blocks for new DNA.
II. Taq polymerase synthesizes DNA in the 3' to 5' direction.
III. Magnesium ions act as an essential cofactor for polymerase.
IV. Primers are long double-stranded DNA molecules.
V. The buffer maintains optimal pH and salt concentration.
Which of the above statement(s) is/are correct?
(A) I, III and V
(B) I, II, III and V
(C) I, IV and V
(D) II, III, IV and V

2011
231. The 648 bp COI fragment used in DNA barcoding is sometimes called the Folmer region, named after the scientist who designed what crucial tool?
(A) The DNA sequencing machine
(B) The COI universal primers
(C) The DNA extraction protocol
(D) The phylogenetic algorithm

2025
232. Which molecular marker is generally considered co-dominant, highly polymorphic, and historically the gold standard for parentage analysis in aquaculture?
(A) AFLP
(B) RAPD
(C) Microsatellites
(D) Mitochondrial D-loop

NODIA

2013
233. The principle of typification dictates that every named species must be objectively tied to what?
(A) A published genetic sequence
(B) A specific type specimen or series of specimens
(C) A distinct geographical location

(D) A detailed ecological description

2019

234. In classical ichthyotaxonomy, the count of branched rays in the dorsal fin is recorded primarily using which numbering system?
(A) Arabic numerals
(B) Roman numerals
(C) Greek letters
(D) Alphabetic characters

2024

235. The concept of "punctuated equilibrium" in fish evolution suggests that morphological changes occur primarily during what phase?
(A) Slow, continuous geological eras
(B) Short bursts of rapid speciation followed by long stasis
(C) Only during mass extinction events
(D) Symmetrically over millions of years

2001

236. What is the primary histological feature distinguishing a mature, hydrating oocyte from a vitellogenic oocyte?
(A) Fusion of yolk globules and massive influx of water
(B) Accumulation of yolk proteins
(C) Multiplication of the nucleoli
(D) Formation of the theca layer

2004

237. The brooding of eggs in the specialized abdominal pouch is characteristic of reproduction in which male fish?
(A) Seahorse (Syngnathidae)
(B) Tilapia
(C) Catfish
(D) Salmon

2023

238. In teleosts, what is the specific role of 17alpha,20beta-dihydroxy-4-pregnen-3-one (17,20beta-P)?
(A) It acts as the primary maturation-inducing steroid
(B) It initiates early vitellogenesis
(C) It stimulates primary spermatogonial proliferation
(D) It inhibits GnRH release

2024

239. Crustacean eyestalk ablation destroys the X-organ-sinus gland complex, thereby rapidly decreasing the circulating levels of which hormone?
(A) Ecdysone
(B) Progesterone
(C) Gonad-inhibiting hormone
(D) Thoracic gland hormone

2019

240. The following question consists of two statements, one labelled as Assertion (A) and the other labelled as Reason (R).
Assertion (A): The Gonadosomatic Index (GSI) is heavily relied upon to determine the specific spawning season of a fish population.
Reason (R): GSI values increase significantly due to gonad enlargement just prior to and during the spawning season.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2009

241. A relative gut length (RGL) of roughly 0.5 to 0.8 characterizes fishes with what dietary preference?
(A) Carnivorous
(B) Herbivorous
(C) Omnivorous
(D) Detritivorous

2012

242. Kupffer's vesicle is a transient embryonic organ in teleosts that is primarily involved in establishing what?
(A) Left-right asymmetry
(B) Dorsal-ventral patterning
(C) The optic cup
(D) The digestive tract

2023

243. The trocophore larva is a ciliated, free-swimming stage common to both polychaetes and which other major group?
(A) Molluscs
(B) Teleosts
(C) Crustaceans
(D) Echinoderms

2013

244. Otoliths are technically not bones; what structure within the inner ear are they housed in?
(A) The labyrinth organ
(B) The lateral line canal
(C) The swim bladder
(D) The Weberian apparatus

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2015

245. When fitting length-frequency data to the von Bertalanffy growth model, ELEFAN algorithms optimize the fit by maximizing which score?
(A) *Rn* (goodness of fit index)
(B) Sum of squared errors
(C) Maximum Sustainable Yield
(D) Natural mortality rate

2003

246. In fisheries acoustics, target strength (TS) is an empirical measure used to estimate what attribute of the fish?
(A) Fish size or biomass
(B) Swimming speed
(C) Age
(D) Trophic level

2008

247. Maximum Economic Yield (MEY) occurs at an effort level that is typically positioned where relative to Maximum Sustainable Yield (MSY)?
(A) At a lower effort level than MSY
(B) At a higher effort level than MSY
(C) Exactly at the same effort level as MSY
(D) Completely unrelated to effort

2002

248. The synchronized, large-scale oceanic migration of tunas is primarily driven by the seasonal availability of what?
(A) Thermal fronts and food
(B) Availability of mates
(C) Fresh water influxes
(D) Deep oceanic trenches

2012

249. Which fish pass is specifically designed primarily as a gently sloping, roughened channel to simulate natural rapids?
(A) Rock-ramp fishway
(B) Fish elevator
(C) Vertical slot
(D) Denil fishway

2017

250. Match the marking or tagging techniques in List I with their defining characteristics in List II.
List I: Tagging Techniques
P. Elastomer tag
Q. PIT tag
R. Coded Wire Tag (CWT)
S. Acoustic tag
List II: Defining Characteristics
1. Emits ultrasonic pings
2. Microscopic magnetized wire injected into the snout
3. Visually distinct fluorescent polymer injected sub-dermally
4. Read by passing through an electromagnetic scanner
(A) P-3, Q-4, R-2, S-1
(B) P-4, Q-3, R-1, S-2
(C) P-2, Q-1, R-4, S-3
(D) P-3, Q-2, R-4, S-1

2014

251. INCOIS issues PFZ advisories for Indian coasts. What is the fundamental limitation of optical satellite remote sensing used in this process?
(A) Inability to detect temperature
(B) Obstruction by dense cloud cover
(C) Requirement of water sampling
(D) Nighttime operational limits

NODIA

2016

252. The FAO Code of Conduct for Responsible Fisheries provides the overarching framework for MCS. Is this code legally binding?
(A) No, it is strictly a voluntary instrument
(B) Yes, entirely legally binding globally
(C) Yes, but only for developing nations
(D) Yes, but only concerning aquaculture

2025

253. In DNA isolation from fin clips, what chemical is commonly used in lysis buffers to break down cell membranes?
(A) Sodium dodecyl sulfate (SDS)
(B) Ethidium bromide
(C) Isopropanol
(D) Agarose

2024

254. Metabarcoding relies heavily on High-Throughput Sequencing (HTS). Which technology is considered a standard HTS platform for this?
(A) Illumina Sequencing
(B) Sanger Sequencing
(C) Maxam-Gilbert Sequencing
(D) Edman Degradation

2024

255. A population genetic study utilizes SNPs rather than microsatellites primarily because SNPs offer what distinct advantage?
(A) They are ubiquitous and easily automated for genome-wide screening
(B) They have multiple alleles per locus
(C) They represent higher mutation rates
(D) They require completely intact, live cells

2018

256. Neotypes are designated under the International Code of Zoological Nomenclature in what specific scenario?
(A) When the original holotype is lost or destroyed
(B) When a new subspecies is discovered
(C) When revising a family name
(D) When merging two distinct genera

2002

257. Which meristic character is counted along the lateral line from the operculum to the hypural joint?
(A) Lateral line scales
(B) Pectoral fin rays
(C) Branchiostegal rays
(D) Gill rakers

2013

258. Phylogenetic trees constructed using maximum likelihood algorithms rely on what fundamental component?
(A) Explicit mathematical models of nucleotide sequence evolution
(B) Distance matrices alone
(C) Strict morphological counts
(D) Fossil radiocarbon dating only

2022

259. During oocyte atresia in teleosts, which cells hypertrophy and actively phagocytize the degenerating yolk?
(A) Granulosa cells
(B) Theca cells
(C) Primordial germ cells
(D) Red blood cells

2007

260. The statocyst in bivalve molluscs serves as a sensory organ primarily responsible for detecting what?
(A) Gravity and spatial orientation
(B) Light intensity
(C) Salinity gradients
(D) Chemical sex pheromones

2022

261. In the teleost HPG axis, gonadotropins (FSH and LH) are structurally classified as what type of hormones?
(A) Glycoproteins
(B) Steroids
(C) Small peptides
(D) Catecholamines

2017

262. In the hormonal regulation of crustacean molting, what specific action does ecdysone take after being secreted?
(A) Conversion to active hormone
(B) Breakdown of the exoskeleton
(C) Inhibition of the Y-organ
(D) Triggering of rapid spawning

2007

263. Fecundity in teleosts generally exhibits a stronger correlation with which somatic parameter?
(A) Total weight
(B) Body depth
(C) Head length
(D) Eye diameter

2012

264. A high frequency of empty stomachs in a sampled fish population during a specific season often indicates what physiological state?
(A) Active spawning or intense migratory phase
(B) Isometric growth
(C) Somatic hyper-growth
(D) High parasitic load

2003

265. What marks the completion of the cleavage stage and the beginning of the blastula stage in teleost embryos?
(A) Formation of the blastocoel
(B) Closure of the blastopore
(C) Formation of the neural tube
(D) Hatching from the chorion

2004

266. Which larval stage of the freshwater prawn (Macrobrachium rosenbergii) requires brackish water for survival and development?
(A) Zoea
(B) Nauplius
(C) Megalopa
(D) Spat

2021

267. Daily growth increments in otoliths are validated historically using which fluorescent chemical marker?
(A) Calcein or Oxytetracycline
(B) Formalin
(C) Rose Bengal
(D) Ethidium Bromide

2013

268. In the length-weight relationship equation $W = aL^b$, if the environment becomes highly

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unfavorable, what is the expected impact on parameter 'a' (condition factor)?
(A) It significantly decreases
(B) It becomes exactly 3.0
(C) It significantly increases
(D) It converts to a negative value

2010

269. The cohort analysis method utilized in fisheries population dynamics fundamentally requires data organized by what metric?
(A) Age classes
(B) Weight classes
(C) Spatial distribution grids
(D) Diet composition

2013

270. Recruitment in fishery models is formally defined as the number of individuals reaching what specific demographic milestone?
(A) Age or size at first entry into the exploitable fishery
(B) Maximum age
(C) Hatching stage
(D) Length at first maturity

2019

271. Potamodromous fishes migrate entirely within what specific type of aquatic environment?
(A) Freshwater systems
(B) Estuaries
(C) Oceans
(D) Hypersaline lakes

2018

272. The efficiency of a fish pass is critically evaluated by measuring what specific biological metric?
(A) Proportion of successful ascent
(B) Total water volume discharged
(C) Dissolved oxygen levels created
(D) Reduction in overall dam height

2022

273. Pop-up Satellite Archival Tags (PSATs) are typically programmed to do what at the end of their deployment?
(A) Detach and transmit to satellite
(B) Dissolve into the water column
(C) Emit electric shock to the fish
(D) Anchor permanently to the seabed

2013

274. In remote sensing for fisheries, Sea Surface Temperature (SST) is primarily measured using sensors operating in which spectral bands?
(A) Thermal infrared and microwave
(B) Ultraviolet and X-ray
(C) Purely visible green light
(D) Gamma rays

2007

275. Which component of Monitoring, Control, and Surveillance (MCS) specifically involves the legal framework and licensing?
(A) Control
(B) Monitoring
(C) Surveillance
(D) Enforcement

2016

276. What is the fundamental purpose of running a PCR product through an agarose gel electrophoresis?
(A) To separate and verify the size of the amplified DNA fragments
(B) To sequence the exact nucleotides
(C) To translate DNA into protein
(D) To splice genes into plasmids

NODIA

2003

277. The Bold Systems (BOLD) database is specifically dedicated to curating and providing analysis tools for what type of data?
(A) DNA barcode sequences and associated voucher data
(B) Global commercial fish landings
(C) Real-time satellite SST imagery
(D) Fishing vessel registry records

2024

278. Population bottlenecks cause what specific measurable effect on a fish population's genetic structure over time?
(A) Significant loss of genetic diversity and heterozygosity
(B) Increased mutation rate
(C) Increase in polyploidy
(D) Enhanced panmixia

2006

279. The term "paratype" in taxonomy designates what specific type of specimen?
(A) Any specimen from the type series other than the holotype
(B) The single specimen designated as the name-bearing type
(C) A specimen collected from a different continent
(D) A theoretical model of the species

2014

280. Which meristic feature is specifically defined as the number of bony arches supporting the gills?
(A) Branchial arches
(B) Branchiostegal rays
(C) Gill rakers
(D) Pectoral rays

2023

281. In cladistics, what term describes a trait that is derived and uniquely present in only one specific taxon?
(A) Autapomorphy
(B) Synapomorphy
(C) Symplesiomorphy
(D) Homoplasy

2011

282. The micropyle of a teleost egg closes immediately after the entry of the first spermatozoon primarily to prevent what?
(A) Polyspermy
(B) Desiccation
(C) Yolk leakage
(D) Viral infection

2018

283. The reproductive organ known as the "oviducal gland" is critically important for egg case formation in which aquatic animals?
(A) Elasmobranchs and cephalopods
(B) Teleosts
(C) Bivalves
(D) Penaeid shrimps

2021

284. Which neuroendocrine factor in teleosts strongly stimulates the release of Growth Hormone, which in turn can influence reproductive timing?
(A) Growth Hormone-Releasing Hormone (GHRH)
(B) Somatostatin
(C) Dopamine
(D) Prolactin

2022

285. In crustacean physiology, the androgenic gland directly determines male sexual characteristics regardless of what factor?
(A) Genetic sex determination
(B) Water temperature
(C) Molt stage
(D) Salinity

2023

286. Which statistical parameter indicates the size at which 50% of the individuals in a fish population have reached sexual maturity?
(A) $L_{\{50\}}$
(B) L_∞
(C) t_0
(D) Z

2013

287. Which method directly measures the rate at which food is processed and expelled from the fish gut?
(A) Gastric evacuation rate
(B) Gastrosomatic index
(C) Relative gut length
(D) Electivity index

2010

288. During the ontogeny of flatfishes (Pleuronectiformes), the defining metamorphic event involves what profound morphological change?
(A) Migration of one eye to the opposite side of the head
(B) Loss of the caudal fin
(C) Complete loss of scales
(D) Transition from a cartilaginous to a bony skeleton

2022

289. The cypris larval stage, characterized by a bivalved carapace, is unique to the settlement phase of which organism?
(A) Barnacles
(B) Oysters
(C) Crabs
(D) Squids

2008

290. What specific anatomical orientation must an otolith be sectioned in to accurately read annular rings in most teleosts?
(A) Sagittal or transverse plane
(B) Tangential plane
(C) Oblique plane
(D) Cortical plane

2019

291. Which parameter of the von Bertalanffy growth equation represents the theoretical age when a fish's length is zero?
(A) t_0
(B) K
(C) L_∞
(D) W_∞

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2002

292. In a heavily exploited fishery, if the Catch per Unit Effort (CPUE) declines steadily over years, it is a primary indicator of what?
(A) Decreasing population abundance
(B) Decreasing natural mortality
(C) Increasing gear efficiency
(D) Increasing recruitment

2021

293. The concept of "Maximum Sustainable Yield" is mathematically derived from the peak of the curve in which surplus production model?
(A) Schaefer
(B) Beverton-Holt
(C) Ricker
(D) von Bertalanffy

2006

294. What environmental trigger is most commonly associated with the initiation of downstream migration in catadromous eels?
(A) Autumn moon and low temperature
(B) Spring flood and high temperature
(C) Mid-summer drought conditions
(D) Winter ice formation patterns

2021

295. Which type of fish way acts similarly to a canal lock for ships, trapping fish in a lower chamber and raising the water level?
(A) Fish lock
(B) Fish elevator
(C) Denil fishway
(D) Vertical slot

2018

296. A primary disadvantage of using internal anchor tags (e.g., T-bar tags) compared to electronic tags is what?
(A) They provide only point-to-point data (release and recapture locations)
(B) Requirement of expensive scanners
(C) Rapid depletion of internal power
(D) Continuous transmission of sound

2013

297. What oceanic feature, often targeted in PFZ forecasting, acts as a physical boundary concentrating nutrients, phytoplankton, and pelagic fishes?
(A) Thermal fronts and eddies
(B) Abyssal plain formations
(C) Benthic hypoxic zones
(D) Coral bleaching areas

NODIA

2019

298. Catch Quotas (Total Allowable Catch) fall under which specific category of fisheries management tools within an MCS framework?
(A) Output controls
(B) Input controls
(C) Technical measures
(D) Surveillance tools

2008

299. In the context of PCR, what is the role of a thermal cycler?
(A) Automate temperature shifts
(B) Cool DNA for preservation
(C) Sequence the DNA directly
(D) Synthesize RNA templates

2007

300. Genetic introgression, which can be quantified using nuclear markers, specifically refers to what process?
(A) Interspecific gene transfer
(B) Isolation of populations
(C) Mutation of mitochondrial DNA
(D) Random loss of genetic alleles

****

ANSWERS

1. (B) Principle of Priority
The International Code of Zoological Nomenclature establishes specific guidelines to maintain naming stability in biology. This particular rule dictates that the oldest available name for a taxon takes precedence over subsequently proposed names. This systematic approach prevents confusion when multiple scientists describe the same organism, ensuring that a single, historically accurate scientific name remains globally recognized and accepted.

2. (D) Number of lateral line scales
Meristic characters are discrete anatomical features that can be counted rather than measured. These traits are highly valuable for taxonomic identification because they typically remain stable once development is complete. Tracking the quantity of scales along the sensory canal provides a precise method for distinguishing between closely related species that may otherwise appear morphologically similar in overall body shape.

3. (A) Allopatric speciation
Geographical isolation leads to the formation of new species when a physical barrier like a mountain range or ocean separates a population. Over time, these isolated groups undergo distinct genetic changes due to different environmental pressures and mutations. This process prevents gene flow, eventually resulting in reproductive isolation and the development of unique biological characteristics within the separated fish groups.

4. (C) Granulosa layer
During the development of teleost oocytes, specific cellular layers provide essential support and nutrients. One particular layer is situated immediately around the oocyte, playing a critical role in the transport of yolk precursor proteins. These cells facilitate the uptake of vitellogenin from the bloodstream, which is necessary for the growth and eventual maturation of the developing fish egg.

5. (A) Male differentiation
In crustaceans, sexual development is governed by a specialized endocrine structure found in males. This gland produces hormones that trigger the development of primary and secondary male characteristics, including the formation of testes and specialized appendages. Without the influence of these hormones during early life stages, the individual would naturally develop female traits regardless of its underlying genetic makeup.

6. (D) Gonadotropin-releasing hormone
The reproductive cycle in fishes is controlled by a complex hormonal pathway involving the brain and the pituitary gland. A specific neurohormone is produced in the hypothalamus and travels to the pituitary to stimulate the secretion of gonadotropins. This chemical signal acts as the primary trigger for the entire reproductive axis, ultimately coordinating the maturation of gametes and spawning.

7. (B) Gonad-inhibiting hormone
Penaeid shrimps possess an endocrine system located within their eyestalks that regulates various physiological functions, including reproduction. Removing one eyestalk eliminates a major source of a specific hormone that naturally prevents the ovaries from maturing. This surgical intervention lowers the inhibitory signals in the bloodstream, allowing the shrimp to enter the reproductive phase and produce eggs more rapidly.

8. (C) Total body weight
Fisheries biologists use a specific index to quantify the reproductive state of a fish by comparing the mass of the reproductive organs to the overall size of the animal. This calculation involves dividing the weight of the gonads by the total mass of the individual. A higher value typically indicates that the fish is approaching its peak spawning period.

9. (D) Herbivorous
The digestive anatomy of a fish reflects its primary source of nutrition and dietary requirements. Species that consume plant material or algae typically require a much longer intestinal tract to maximize the absorption of nutrients from fibrous or low-energy food. A high

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ratio of intestinal length to total body length is a definitive morphological indicator of a plant-based diet.

10. (B) II and III
The early development of teleost fishes is characterized by a specific type of cellular division where only a small portion of the egg undergoes cleavage. This process occurs at the animal pole, leading to the formation of a distinct disc of cells known as the blastodisc. Because the large yolk mass does not divide, the cleavage is considered incomplete.

11. (B) Zoea
Penaeid shrimps undergo several distinct morphological transformations during their early life history before reaching the juvenile stage. After hatching as simple nouplii, they transition into a more complex form characterized by the presence of compound eyes and thoracic appendages. This second major larval phase is essential for swimming and feeding in the water column as the shrimp grows.

12. (B) Otoliths
Researchers determine the age of larval fishes by examining microscopic structures located within the inner ear. These calcified elements deposit layers of material in a rhythmic, daily cycle, creating visible rings that act as a biological calendar. Because these structures are less prone to resorption than scales or bones, they provide the most accurate record of early growth.

13. (A) Asymptotic length
The standard mathematical model used to describe fish growth includes a parameter that defines the theoretical limit of an individual's size. This value represents the average maximum length that members of a specific population would reach if they lived indefinitely. It serves as a critical reference point for understanding the growth potential and life history of different fish species.

14. (C) Predation
Fish populations experience losses from various causes, which are categorized into two primary types of mortality. One type includes all deaths resulting from biological or environmental factors rather than human fishing activity. Being consumed by other animals is a major component of these natural losses, significantly influencing the abundance and age structure of the population in the wild habitat.

15. (B) Recruitment
Mathematical models in fisheries science help predict how many young individuals will survive to join the exploitable population each year. This specific model accounts for density-dependent factors that influence the survival of larvae and juveniles. By understanding this relationship, managers can estimate the number of new fish entering the fishery and set sustainable harvest limits to protect stocks.

16. (C) Catadromous
Certain fish species exhibit a unique migratory pattern where they spend the majority of their adult lives in freshwater rivers but return to the sea to reproduce. This behavior ensures that the eggs hatch in marine environments, which may offer specific advantages for larval survival. The European eel is a classic example of a fish that follows this specific lifecycle.

17. (C) Pool and weir fishway
Migrating fish often encounter obstacles like dams that prevent them from reaching upstream spawning grounds. One common solution involves a structure consisting of a series of stepped chambers. Each chamber is separated by a low wall, creating a sequence of small waterfalls and resting areas. This design allows fish to ascend the barrier by jumping between successive pools.

18. (D) Passive Integrated Transponder
Modern fish tracking utilizes small electronic tags that do not require an internal power source. These devices remain dormant until they are activated by a specific radio frequency from a reader. When energized, the tag transmits a unique identification code, allowing researchers to monitor individual fish movements and survival rates without the need for large batteries or external attachments.

19. (B) Chlorophyll-a concentration
Identifying areas with high concentrations of fish involves analyzing satellite data that tracks ocean productivity. Satellites measure the color of the sea surface to estimate the amount of photosynthetic pigment present in the water. High levels of this pigment indicate abundant phytoplankton, which forms the base of the

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food web and attracts schools of fish to these productive zones.

20. (B) I and III
Tracking fishing vessels is essential for effective fisheries management and ensuring compliance with maritime regulations. Modern systems use satellite technology to provide real-time updates on a boat's location and heading. These tools are fundamental components of the surveillance framework, helping authorities monitor protected areas and verify that vessels are operating within their permitted zones and seasons.

21. (A) Proteinase K
During the process of isolating genetic material from biological tissues, it is necessary to break down cellular structures and release the DNA. A specialized enzyme is added to the mixture to digest various proteins, including those that package DNA or could potentially degrade it. This step ensures that the resulting sample is clean and suitable for further molecular analysis.

22. (D) Cytochrome c oxidase I
DNA barcoding uses a specific genetic sequence to identify and distinguish between different animal species. In fishes, a portion of a mitochondrial gene involved in cellular respiration is the globally recognized standard for this purpose. This marker is ideal because it evolves at a rate that allows for the clear differentiation of species while remaining relatively consistent within a population.

23. (A) Short tandem repeats
Genetic markers used to study fish populations often consist of non-coding DNA regions where small sequences of nucleotides are repeated multiple times. These regions are highly variable because the number of repeats can change frequently between generations. This high level of polymorphism makes them excellent tools for identifying individuals, determining parentage, and analyzing the genetic structure of different stocks.

24. (C) Genus
Biological classification follows a hierarchical structure that organizes organisms based on their shared characteristics and evolutionary history. In this system, several closely related groups are clustered together within a larger family. The level immediately following the family contains one or more groups of species that share very similar traits and a common ancestor, providing a more specific classification.

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25. (A) Measurements
Fish identification relies on two primary types of physical characteristics. One category involves the quantification of body shapes and dimensions, such as the length of the head or the depth of the body. These values are often expressed as ratios or proportions. Unlike traits based on counting discrete structures, these features capture the overall physical geometry of the animal.

26. (B) Convergent evolution
Unrelated species often develop similar physical traits when they live in similar environments or face comparable survival challenges. This biological phenomenon occurs because specific body shapes or behaviors provide a distinct advantage for survival, leading different lineages to evolve along similar paths. A classic example is the streamlined body shape found in both sharks and dolphins despite their different ancestries.

27. (D) Seminiferous lobules
The production of sperm in male teleost fishes takes place within specialized compartments inside the testes. These structures contain various stages of developing germ cells supported by specialized somatic cells. The process involves multiple divisions and transformations, eventually leading to the release of mature spermatozoa into the duct system, where they can be stored or released during spawning events.

28. (C) Digestion
Bivalve molluscs possess a unique anatomical structure consisting of a rotating rod located within the stomach. This organ releases enzymes that break down food particles and helps move materials through the digestive tract. The continuous rotation of this rod, combined with the chemical action of the enzymes it secretes, is essential for the efficient processing of nutrients from filtered water.

29. (D) Liver
In female fishes, the production of yolk proteins is a critical step in the development of eggs. This process begins when hormones signal a specific internal organ to synthesize a precursor protein known as vitellogenin. Once produced, this protein is released into the bloodstream and

transported to the ovaries, where it is taken up by the developing oocytes to provide nourishment.

30. (A) I, II and III
The molting cycle in crustaceans is regulated by a complex interplay of hormones and specialized organs. One organ produces steroids that trigger the shedding of the old exoskeleton, while another structure within the eyestalk releases hormones that normally prevent this process. This balance ensures that molting occurs at the appropriate time for growth and development throughout the animal's life.

31. (B) Mature ova in ovary
Reproductive potential in fishes is often measured by counting the number of eggs an individual can produce. One specific metric focuses on the total quantity of ripened eggs present in the ovaries just before a spawning event occurs. This value provides a direct estimate of the maximum number of offspring a female could potentially contribute to the next generation.

32. (A) Feeding intensity
Biologists monitor the nutritional status and activity levels of fish by comparing the weight of the digestive tract to the total mass of the individual. A higher value indicates that the fish has recently consumed a large amount of food. This index is useful for identifying peak foraging periods and understanding the ecological role of a species within its environment.

33. (A) Gastrulation
During the early development of a fish embryo, cells undergo complex movements to establish the primary body layers. One specific movement involves the expansion of a sheet of cells over the surface of the yolk. This process is essential for creating the basic body plan and occurs during the stage where the embryo transitions from a simple ball of cells.

34. (D) Molluscs
Many aquatic invertebrates go through a unique larval stage characterized by a specialized swimming organ called a velum. This ciliated structure allows the larva to move through the water and capture food particles. This specific developmental phase is found in various groups of snails, clams, and their relatives, serving as a critical period for dispersal before they eventually settle.

35. (A) Temperature
The growth of fish scales is influenced by seasonal changes in the environment. During periods of slow growth, often associated with colder water, the rings on the scales become more tightly packed, forming a distinct band. By counting these bands, scientists can estimate the age of a fish, as each band typically represents one year of life in temperate regions.

36. (C) 3.0
The relationship between the length and weight of a fish is often described by a mathematical power function. If a fish maintains its overall shape and proportions as it grows, the exponent in this equation will be exactly three. This type of growth implies that the volume and weight increase in direct proportion to the cube of the animal's length.

37. (B) Fishing mortality
The total rate at which individuals are removed from a fish population is determined by two main factors. One component accounts for all deaths due to natural causes such as disease and predation. The second component represents the loss of fish due to capture by commercial, recreational, or subsistence fishing. Combining these two values provides the overall mortality rate.

38. (B) Cannibalism
This ecological model describes how the number of new individuals joining a population changes relative to the size of the adult stock. At very high densities, the abundance of recruits may actually decrease because the adults compete for resources or consume their own young. This compensatory mechanism helps regulate population size and is a key feature of certain stock-recruitment relationships.

39. (A) Marine waters
Migratory patterns in fishes vary based on the environments they inhabit and the distances they travel. Some species perform long-distance movements entirely within saltwater habitats, never entering freshwater or estuaries. These migrations are often driven by the need to find optimal feeding grounds or specific oceanic conditions for spawning, as seen in many large, pelagic fish species.

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40. (A) Both A and R are true and R is the correct explanation of A.
Designing effective structures for fish passage requires understanding the swimming capabilities of different species. One specific design uses internal baffles to slow down the water flow, creating a manageable environment for fish to swim upstream. This mechanism is highly effective because it provides lower-velocity zones that allow smaller or weaker swimmers to overcome the force of the current.

41. (A) Signal attenuation
Tracking fish using sound waves is a common method in aquatic research, but certain environmental conditions can interfere with the signal. In areas where the water is highly turbulent or filled with air bubbles, the sound pulses can be scattered or absorbed. This reduction in signal strength makes it difficult for receivers to detect and accurately record the fish's position.

42. (C) Large pelagic species
Satellite technology allows researchers to monitor the movements of marine animals over vast distances. Because the tags must reach the surface to transmit data to satellites, this method is most effective for animals that spend significant time in the upper layers of the ocean. It is frequently used to track the long-distance migrations of sharks, tunas, and billfishes.

43. (A) UNCLOS
International law provides a comprehensive framework for the management and protection of the world's oceans. This agreement defines the rights and responsibilities of nations regarding their use of marine resources and the establishment of maritime zones. It serves as the legal foundation for monitoring and controlling fishing activities within the exclusive economic zones of coastal states around the world.

44. (C) DNA strands separate
The process of amplifying specific DNA sequences involves several temperature-dependent steps. In the initial phase, the sample is heated to a high level, which causes the double-stranded DNA to break its hydrogen bonds. This results in two single strands, which then serve as templates for the synthesis of new DNA during the subsequent stages of the reaction cycle.

45. (C) Simultaneous multi-taxa ID
Modern genetic techniques allow researchers to identify many different species from a single mixed sample, such as the contents of a fish's stomach. This approach is much more efficient than traditional methods that require analyzing each item individually. By sequencing DNA from the entire sample at once, scientists can get a complete picture of the predator's diet and ecosystem.

46. (A) High-throughput screening
Certain genetic markers are favored in large-scale studies because they can be analyzed quickly and efficiently using automated technology. These markers consist of single-base variations in the DNA sequence and are found in high numbers throughout the genome. Their simplicity and abundance allow researchers to gather vast amounts of data on population structure and genetic diversity across many individuals.

47. (C) Subspecies
The scientific name of an organism usually consists of two parts, but in some cases, a third name is added to provide more detail. This additional term is used to identify a distinct population within a species that has unique characteristics or a specific geographic range. This three-part naming system helps biologists recognize and study variation within a broader species group.

48. (C) Base of caudal fin
When measuring the length of a fish, scientists often use a standardized distance that excludes the tail fin. This measurement starts at the front of the snout and ends at the point where the vertebral column stops and the tail begins. This approach is useful because it provides a consistent value that is not affected by damage or wear to the tail.

49. (A) Absence of geographical barriers
Speciation can occur even when there is no physical separation between populations living in the same area. In these cases, reproductive isolation may develop through differences in behavior, habitat preference, or the timing of spawning. This process allows two distinct groups to evolve into separate species while still sharing the same environment, without the need for an external barrier.

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50. (A) P-4, Q-1, R-2, S-3
Understanding fish reproduction requires a clear definition of the various stages and processes involved. These terms describe everything from the initial germ cells and the accumulation of nutrients in the egg to the eventual release of sperm and the natural breakdown of unused eggs. Correctly mapping these definitions is essential for studying the life history and reproductive health of fish populations.

51. (C) Cephalopoda
Certain marine invertebrates have evolved specialized structures for the transfer of genetic material during reproduction. In one specific group, males possess a modified arm that is used to pick up sperm packets and place them within the female's mantle cavity. This unique anatomical feature is a key characteristic of squids, octopuses, and their close relatives within the molluscan family.

52. (C) Germinal vesicle breakdown
The final stage of egg maturation in fishes is triggered by a specific steroid hormone. This chemical signal causes the nucleus of the oocyte to dissolve, which is a necessary step before the egg can be fertilized. This event marks the transition from a developing cell to a fully mature gamete that is ready for release during the spawning process.

53. (B) Androgenic gland hormone
The development of male characteristics in crustaceans is controlled by a specific endocrine organ. This gland secretes hormones that promote the growth of male reproductive structures and secondary sexual traits. Simultaneously, these hormones act to prevent the expression of female characteristics, ensuring that the individual develops as a functional male throughout its growth and maturation process in the aquatic environment.

54. (B) Minimum legal catch size
Fisheries management often involves setting rules to ensure that enough fish survive to reproduce. One critical regulation defines the smallest size at which a fish can be legally harvested. This limit is based on biological data regarding the size at which individuals in a population typically become sexually mature, helping to maintain the spawning stock for future generations.

55. (C) Other fishes
The length of a fish's digestive tract is closely linked to its diet and the complexity of the food it consumes. Species that primarily eat other animals usually have a relatively short and simple intestine because animal tissue is easy to digest and nutrient-dense. A ratio of gut length to body length below one is typical for these predatory fish.

56. (B) Gastrulation
After the initial stages of cell division and the formation of the primary body layers, a fish embryo begins to develop its internal organs and specialized tissues. This phase of development starts once the cells have moved into their proper positions to form the basic body plan. This critical transition leads to the formation of the nervous system, heart, and other essential structures.

57. (C) Oyster
The life cycle of certain bivalve molluscs involves a transition from a free-swimming larval stage to a sedentary adult form. After searching for a suitable surface, the larva attaches itself permanently and begins to grow its shell. This newly settled juvenile is referred to by a specific name and represents a critical stage in the commercial production and natural recovery.

58. (C) Sagitta
Fish possess three pairs of small calcified structures in their inner ears that aid in balance and hearing. In most species, one particular pair is much larger than the others, making it the preferred choice for scientific study. These structures are frequently used for age determination because they clearly show annual and daily growth rings, providing a reliable record of life.

59. (B) Rate of approach to L_∞
In mathematical growth models, a specific coefficient determines how quickly a fish reaches its maximum potential size. A higher value for this parameter indicates that the fish grows rapidly in its early years and reaches its asymptotic length sooner. This rate is a fundamental biological characteristic that varies between species and is influenced by environmental factors like temperature and food.

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60. (A) Morula → Blastula → Gastrula → Organogenesis
The development of a fish from a fertilized egg follows a precise sequence of stages. It begins with a series of rapid cell divisions, leading to a solid ball of cells, followed by the formation of a hollow structure. Next, the cells move to create primary layers, and finally, the specialized organs and tissues begin to take shape before the embryo hatches.

61. (B) Growth overfishing
This type of overfishing occurs when fish are harvested at a size smaller than what would produce the maximum total weight from the population. By allowing fish to grow larger before capture, the overall yield from the fishery can be increased. Scientists use specialized models to determine the optimal size at first capture to maximize the benefits for the fishing industry.

62. (B) Feeding and growth
Some fish species migrate between freshwater and saltwater environments at different stages of their lives for reasons other than reproduction. These movements are often driven by the search for better foraging opportunities or more suitable conditions for growth. This flexible migratory strategy allows the fish to take advantage of the high productivity found in both marine and riverine habitats.

63. (B) High water velocity
Dams and other barriers often create areas where the water flows too quickly for fish to swim against it. Fish ladders are designed to solve this problem by breaking the fall of the water into smaller steps. By reducing the overall speed of the current, these structures create a path that fish can successfully navigate as they move toward their spawning grounds.

64. (A) High tag shedding rates
While external tags are easy to apply and visible to the naked eye, they often fall off before the fish can be recaptured. This loss of tags can lead to errors in estimating population size and survival rates. Factors such as poor attachment, fish growth, or the tag getting snagged on underwater structures contribute to this common problem in tagging studies.

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65. (B) Phytoplankton
Remote sensing satellites can detect the concentration of microscopic algae in the ocean by measuring the intensity of specific colors reflected from the water. These tiny organisms are the primary producers in marine ecosystems and form the foundation of the food chain. Mapping their distribution helps scientists identify productive areas where fish are likely to aggregate for feeding throughout the ocean.

66. (C) Monitoring compliance and recording bycatch
Observer programs involve placing trained individuals on fishing vessels to collect data on the catch and fishing operations. These observers play a vital role in ensuring that regulations are followed and providing accurate information on the number of non-target species captured. This first-hand data is essential for managing fisheries sustainably and minimizing the impact of fishing on the marine environment.

67. (B) Precipitate DNA
During the final steps of DNA extraction, it is necessary to separate the genetic material from the liquid solution. Adding a specific type of alcohol causes the DNA to clump together and become visible as a solid substance. This allows the researcher to collect the DNA by spinning the sample or carefully removing the liquid, resulting in a purified genetic sample.

68. (B) Low intraspecific variation and high interspecific variation
An effective genetic marker for species identification must show very little difference between individuals of the same species but large differences between different species. This clear distinction, often called the barcode gap, allows scientists to accurately assign an unknown sample to the correct taxon. This property is what makes certain mitochondrial genes so reliable for DNA barcoding across the animal kingdom.

69. (B) Reproductive isolation among spatial units
Managing fisheries effectively requires identifying distinct groups of fish that do not interbreed. Genetic analysis can reveal if populations in different areas are reproductively isolated, meaning they should be managed as separate stocks. This information is crucial for preventing the overexploitation of specific populations and

ensuring the long-term sustainability of the entire fishery across its geographic range.

70. (A) II → IV → III → I
The process of copying DNA in a laboratory involves a repeating cycle of temperature changes. It begins with a high-temperature step to prepare the template, followed by cycles of strand separation, primer binding, and new DNA synthesis. Following this precise order ensures that the target sequence is amplified correctly and efficiently, providing enough material for genetic testing and research.

71. (A) Family
In biological nomenclature, specific suffixes are used to indicate the rank of a taxonomic group. For fishes and other animals, a name ending with these four letters signifies a collection of related genera. This level of classification helps organize species into broader groups based on their shared evolutionary history and physical characteristics, providing a clear structure for scientific study and identification.

72. (C) Body depth
Morphometric measurements capture the physical dimensions of a fish to help with identification and growth studies. One common measurement is the maximum vertical distance from the top of the back to the bottom of the belly. This value provides information about the overall shape and condition of the fish, which can vary depending on its age, sex, and environment.

73. (A) Ancestor and all its descendants
Evolutionary relationships are often described using groups that include a common ancestor and every species that evolved from it. This type of grouping reflects a complete branch of the tree of life and is considered the most accurate way to represent biological history. By focusing on these natural groups, scientists can better understand the evolutionary changes that have occurred over time.

74. (A) Spermiogenesis
The final phase of male gamete development involves the transformation of simple cells into highly specialized, swimming sperm. This process includes the formation of a tail for movement and a specialized head containing the genetic material. This complex structural change is essential for successful fertilization and occurs after the cells have completed their final divisions within the reproductive tissues of the fish.

75. (B) It expands and develops prominent coloration
As female crustaceans approach the spawning period, their reproductive organs undergo significant physical changes. The ovaries grow much larger as they fill with yolk-rich eggs, often becoming visible through the shell. In many species, the color of the organ also changes dramatically, serving as a clear indicator to researchers and aquaculturists that the animal is ready to release its eggs.

76. (B) Inhibits gonadotropin release
In many fish species, the brain produces a chemical that acts as a natural brake on the reproductive system. This substance prevents the pituitary gland from releasing the hormones needed for egg and sperm maturation. Understanding this inhibitory effect is important for aquaculture, as farmers often use specialized treatments to block this chemical and induce spawning in captive fish populations.

77. (C) Eyestalk
Crustaceans possess a specialized neuroendocrine system located within the structures that support their eyes. this complex of organs produces and stores various hormones that regulate critical life processes such as molting, sugar metabolism, and reproduction. The central role of this system makes it a major focus for scientists studying the physiology and growth of shrimps, crabs, and lobsters.

78. (C) Absolute fecundity divided by total body weight
To compare the reproductive output of fish of different sizes, biologists use a standardized value. This is calculated by taking the total number of eggs a female produces and dividing it by her overall mass. This measurement allows for a more accurate assessment of reproductive effort across a population, regardless of individual variations in size or age among the sampled fish.

79. (B) Between 1.0 and 3.0
Fish that consume a variety of both plant and animal matter typically have a digestive tract of moderate length. This anatomy provides enough space to process both nutrient-dense prey and more fibrous plant material. A ratio of gut length to body length within this specific range is a

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common characteristic of species with a flexible and diverse diet in nature.

80. (D) III only
Crustaceans progress through several larval stages, each with unique anatomical features. Early stages often have a limited number of swimming appendages, while later stages develop more complex structures including compound eyes. Identifying the incorrect statement requires recognizing that certain later larval forms do indeed possess functional appendages for movement, even before they reach the final juvenile form after completing their metamorphosis.

81. (A) Pleuronectiformes
Flatfishes undergo one of the most dramatic transformations in the animal kingdom as they develop. They begin life as typical, upright-swimming larvae, but during metamorphosis, one eye moves across the top of the head to join the other on the opposite side. This results in an asymmetrical adult that lives on the seafloor, perfectly adapted for its unique bottom-dwelling lifestyle.

82. (A) Scale reading
Some methods for determining the age of a fish do not require the animal to be killed. By carefully removing a few small plates from the skin, researchers can examine the growth rings under a microscope. This non-destructive technique is valuable for studying protected species or monitoring the growth of individual fish in long-term research projects or commercial aquaculture settings.

83. (A) Condition factor intercept
The mathematical relationship between a fish's length and weight includes a constant that reflects its overall plumpness or physical state. This value serves as an indicator of the animal's health and the suitability of its environment. Changes in this parameter can reveal seasonal variations in food availability or the energy costs associated with reproduction and other critical life stages.

84. (B) Total mortality
Fisheries scientists use a graphical method to estimate the overall rate at which fish are dying in a population. By plotting the abundance of different age or size groups on a graph, they can calculate the slope of the resulting line. This value represents the combined effect of both natural deaths and losses due to fishing, providing a key population parameter.

85. (B) Critical age
As a group of fish born at the same time grows, their individual weight increases while their numbers decrease due to mortality. There is a specific point in time when the total mass of the entire group reaches its maximum value. Identifying this stage is important for fisheries management, as it helps determine the most efficient time to harvest the population.

86. (A) Elver migration
Young eels undergo a significant journey as they transition from the ocean to freshwater habitats. During this stage, they take on a specific form and begin their upstream migration into rivers and streams where they will spend their adult lives. This movement is a critical part of their complex life cycle, which involves traveling vast distances between marine and inland waters.

87. (A) It functions efficiently under fluctuating water levels
Certain fish passage designs are particularly effective because they can handle changes in river height without losing their functionality. By using a specific arrangement of slots and chambers, these structures maintain a consistent flow pattern that fish can navigate regardless of the water level. This versatility makes them a preferred choice for rivers with highly variable seasonal flows and discharge patterns.

88. (B) Mutilation marking
One simple and inexpensive way to identify groups of fish involves removing a small portion of a fin. This permanent mark allows researchers to recognize the fish if they are caught again later. While effective for short-term studies or identifying hatchery-raised fish, it is considered a more invasive technique than using electronic tags or harmless chemical markers on the scales.

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89. (A) Upwelling
Ocean temperatures often show sharp boundaries where cold, nutrient-rich water rises from the deep to the surface. These areas are highly productive because the nutrients support the growth of massive amounts of plankton, which in turn attracts large schools of fish. Identifying

these temperature gradients using satellite data is a primary method for forecasting productive fishing zones in the open ocean.

90. (D) A is false but R is true.
Monitoring systems for fishing vessels do not rely on sound waves, which have a limited range in the ocean. Instead, these systems use satellite-based communication and global positioning technology to track the location of boats anywhere in the world. This provides authorities with accurate and reliable data on vessel movements, which is essential for managing international fisheries and protecting marine resources.

91. (A) 50-65 degrees Celsius
During a laboratory process to copy DNA, the temperature must be carefully controlled to allow small pieces of genetic material to attach to the template. This specific temperature range is low enough for the bonds to form but high enough to ensure that the attachment is precise. Finding the optimal temperature for this step is critical for the success of the reaction.

92. (A) It lacks introns and has a high copy number per cell
Mitochondrial DNA is a preferred tool for genetic identification because it is much more abundant in cells than nuclear DNA. This makes it easier to extract and analyze, especially from small or degraded samples. Additionally, the structure of these genes is simpler, making them ideal for the rapid and standardized sequencing required for DNA barcoding and species differentiation.

93. (A) Significant genetic differentiation
Biologists use a specific statistical value to measure how much genetic difference exists between groups of fish. A high value indicates that there is very little movement of individuals or their genes between the populations, leading them to become genetically distinct over time. This information helps managers decide if different areas should be treated as separate stocks for conservation and harvest.

94. (A) 1758
The modern system of naming animals began with the publication of a landmark scientific work by Carolus Linnaeus. To ensure stability, the rules of nomenclature state that names published before this date are not recognized as valid. This historical cutoff point provides a consistent starting line for the scientific naming of all species, including those found in the world's oceans and rivers.

95. (A) Meristic
Identifying fish species often involves counting specific anatomical features that remain constant throughout the animal's life. These features, such as the number of bony structures within the gill cavity, are excellent for taxonomy because they are not affected by the fish's size or health. These discrete counts provide a reliable and objective way to distinguish between even very similar-looking species.

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96. (A) Shared derived characters (synapomorphies)
Modern biological classification is based on identifying traits that evolved in a common ancestor and were passed down to its descendants. By focusing on these unique, shared characteristics, scientists can build more accurate models of evolutionary history. This approach allows researchers to group organisms based on their true genetic and evolutionary relationships rather than just their outward appearance or shared primitive traits.

97. (A) Sperm entry
The protective outer layer of a fish egg contains a microscopic opening that is essential for fertilization. This tiny pore provides a specific pathway for a single sperm to enter the egg and reach the female genetic material. Once fertilization occurs, the opening quickly closes to prevent other sperm from entering, which is a critical step in the successful development of the embryo.

98. (A) First pleopods
Male penaeid shrimps have specialized reproductive structures that are modifications of their swimming legs. These structures are used to transfer packets of sperm to the female during mating. The presence and shape of these specialized appendages are key characteristics used by biologists to identify different species and determine the sex of individual shrimps during field surveys or aquaculture operations.

99. (A) Gonadotrophs
The pituitary gland contains specialized cells that are responsible for producing the hormones that control reproduction. These cells respond to signals from the brain and release

gonadotropins into the bloodstream, which then travel to the ovaries or testes to stimulate gamete development. The activity of these cells is essential for coordinating the timing of maturation and spawning in all fish species.

100. (A) P-3, Q-2, R-4, S-1
The internal systems that regulate growth and reproduction in marine invertebrates are controlled by various specialized organs. Some organs produce hormones that trigger molting, while others inhibit it or control the development of sexual characteristics. Mapping these organs to their specific functions is fundamental to understanding the complex life histories and physiological processes of crustaceans and molluscs in their natural habitats.

101. (B) 50%
Fisheries scientists define a specific size as the point where a significant portion of a fish population has developed the ability to reproduce. This value is determined by examining a large number of individuals and finding the length at which half of them are sexually mature. This measurement is crucial for setting sustainable fishing limits and ensuring the population can replenish itself.

102. (A) Electivity Index
To understand what fish prefer to eat, researchers compare the items found in their stomachs to what is actually available in the surrounding environment. This index measures whether a predator is actively choosing certain prey or simply eating whatever is most abundant. This information provides deep insights into the foraging behavior and ecological role of different fish species within the food web.

103. (A) Chorion
As a fish embryo prepares to hatch, it produces specialized enzymes that break down the protective outer membrane of the egg. These chemical signals soften the membrane from the inside, allowing the developing larva to break free and enter the surrounding water. This process is carefully timed to ensure that the larva is sufficiently developed to survive independently once it leaves the egg.

104. (A) Pediveliger
Bivalve molluscs go through several larval stages before they settle on the seafloor and begin their sedentary adult lives. One specific stage is characterized by the presence of a foot, which the larva uses to crawl along surfaces and find an ideal location for attachment. This stage represents the final transition before the individual undergoes metamorphosis and becomes a permanent resident.

105. (A) Calcium carbonate
The small structures in a fish's inner ear grow by depositing alternating layers of organic material and a hard mineral. These layers form visible rings that scientists can count to determine the age of the fish, similar to the rings in a tree trunk. The consistent deposition of this mineral throughout the fish's life provides a permanent record of its growth and environmental history.

106. (B) The hypothetical age when the fish's length is zero
Mathematical models of fish growth often include a parameter that accounts for the fact that fish are already a certain size when they hatch. This value represents the theoretical time in the past when the fish would have been zero length based on its later growth rate. It is an important adjustment factor that helps the model more accurately reflect the real-world growth.

107. (A) Pauly's empirical equation
Researchers use a specific formula to estimate the natural death rate of fish populations by considering their growth patterns and the temperature of their environment. This approach is based on the observation that fish in warmer waters or those that grow more quickly tend to have higher mortality rates. This tool is widely used in fisheries management to predict how populations will change over time.

108. (A) Yield per individual recruit
Fisheries management models help determine the level of fishing that will produce the greatest total catch from a group of young fish. This specific value identifies the fishing mortality rate that results in the highest weight of fish harvested for every individual that joins the fishery. By targeting this level, managers can optimize the productivity of the stock and benefit the fishing industry.

109. (A) Increased cortisol and growth hormone
Young salmon undergo a complex physiological transformation as they prepare to move from

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freshwater streams to the ocean. This process involves significant changes in their body chemistry and hormone levels, which help them adapt to the challenges of living in saltwater. These hormonal shifts also trigger physical changes, such as the development of a silvery color, which provides camouflage in the open sea.

110. (B) I and III
Fish exhibit a variety of migratory behaviors to complete their life cycles or find better habitats. Some species move between freshwater and saltwater for spawning, while others perform similar migrations primarily for feeding and growth. Understanding these different strategies is essential for managing fish stocks that cross between different environments and for protecting the critical habitats they rely on throughout their lives.

111. (A) U-shaped or V-shaped baffles on the floor and walls
Certain structures designed to help fish move past dams use a specific arrangement of internal walls or plates. These features create turbulence and slow the water down, making it easier for fish to swim upstream against the current. The unique shape and placement of these baffles distinguish this design from other types of fishways and are key to its effectiveness for many species.

112. (A) Triangulation of sound pulses
Modern tracking systems use an array of underwater receivers to pinpoint the exact location of a fish carrying a sound-emitting tag. By measuring the slight differences in the time it takes for the sound to reach each receiver, scientists can calculate the fish's position with high precision. This method allows researchers to monitor the fine-scale movements and behavior of fish in various aquatic.

113. (A) Sea surface roughness and vessels
Specialized satellite sensors can detect small variations in the texture of the ocean surface, which provides information about wind patterns, waves, and even the presence of ships. This technology is valuable for monitoring fishing activities and ensuring that vessels are operating in permitted areas. By analyzing these signals, authorities can identify potential illegal fishing and manage the safety of maritime.

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114. (A) Daily catch and effort data
Accurate record-keeping is a fundamental part of managing a sustainable fishery. Fishing vessels are often required to maintain a detailed journal of their daily activities, including the quantity of fish caught and the amount of time and gear used. This information provides managers with critical data on the health of the fish stocks and the overall impact of fishing on the marine ecosystem.

115. (A) It is thermostable and resists denaturation
A specialized enzyme used in genetic research is uniquely capable of withstanding the high temperatures required to separate DNA strands. This property allows the enzyme to remain active throughout multiple cycles of heating and cooling, which are necessary for copying specific DNA sequences. Its discovery revolutionized molecular biology by making the amplification of genetic material a much simpler and more efficient process.

116. (B) 648 bp segment at the 5' end
DNA barcoding relies on sequencing a specific, standardized region of a mitochondrial gene. This particular segment is long enough to provide enough genetic variation to distinguish between species but short enough to be easily and reliably amplified in the laboratory. By focusing on this consistent region, scientists around the world can compare their results and build a comprehensive database of species.

117. (A) SNPs are biallelic whereas microsatellites are multiallelic
Genetic markers differ in how they vary within a population. One type of marker consists of single-base changes that usually have only two possible forms. Another common type involves repeating sequences that can vary in length in many different ways, resulting in many possible versions. Each type of marker has unique advantages for studying different aspects of fish genetics and population structure.

118. (A) Principle of Homonymy
The rules of scientific naming ensure that every organism has a unique and unambiguous name. If two different species are accidentally given the same name, a specific principle is used to resolve the conflict. This rule states that the name can only be used for the species it was first assigned

to, and a new name must be found for the other organism.

119. (A) It remains constant regardless of body size
Counting anatomical features like fin rays is a powerful tool for identifying fish because these numbers do not change as the fish grows. Unlike measurements of body length or weight, which are influenced by age and environment, these counts provide a permanent and objective record of the individual's identity. This stability makes meristic characters a cornerstone of traditional and modern fish taxonomy.

120. (B) II only
Understanding evolutionary relationships requires identifying groups of species that share a common ancestor. A group that includes some, but not all, of the descendants of a specific ancestor is considered incomplete and does not accurately reflect a full branch of the evolutionary tree. Recognizing these distinctions is essential for building accurate models of how different fish species have evolved and diversified over millions.

121. (A) First meiotic division
The development of sperm in male fishes involves a specific type of cell division that reduces the amount of genetic material by half. This process begins when specialized cells undergo their first major division, resulting in the formation of two new cells. This critical step ensures that when the sperm eventually fertilizes an egg, the resulting offspring will have the correct number.

122. (A) Sperm receptacle
Female penaeid shrimps have a specialized external structure that is used to receive and store packets of sperm from a male. This organ plays a vital role in the mating process, ensuring that the sperm is available to fertilize the eggs when they are eventually released. The shape and complexity of this structure vary between species and are important for successful reproduction.

123. (A) Vitellogenesis and early spermatogenesis
A specific hormone produced by the pituitary gland plays a major role in the early stages of gamete development in both male and female fishes. In females, it stimulates the accumulation of yolk in the eggs, while in males, it promotes the initial growth and division of sperm cells. This hormone is a key regulator of the annual reproductive cycle for many species.

124. (A) Gonad-stimulating hormone
In crustaceans, a specialized chemical messenger produced in the nervous system is responsible for triggering the maturation of the reproductive organs. This hormone signals the ovaries and testes to begin developing, leading to the production of eggs and sperm. Understanding the role of this hormone is essential for studying the reproductive cycles of shrimps, crabs, and other economically important marine.

125. (A) Relative fecundity
Biologists use a standardized value to compare the egg production of different fish by dividing the total number of eggs by the weight of the individual. This index provides a way to assess the reproductive potential of a population regardless of variations in size among individual fish. It is a useful tool for monitoring the reproductive health and productivity of fish stocks.

126. (A) Carnivorous
The physical characteristics of a fish, such as its teeth and the length of its intestine, are strong indicators of its primary diet. Species with sharp, pointed teeth and a short, straight digestive tract are typically adapted for capturing and quickly processing nutrient-dense animal tissue. These anatomical traits allow the fish to efficiently digest prey like smaller fish, crustaceans, or other aquatic.

127. (A) Neural tube
During the early development of a fish embryo, a specialized structure forms that will eventually become the brain and spinal cord. This tube-like feature is created from the folding of a layer of cells on the surface of the embryo. The successful formation and development of this structure are essential for the growth of a functional nervous system in the growing fish.

128. (A) Brachyuran crab
Crabs go through several distinct larval stages as they grow, with one specific stage marking the transition between the swimming larva and the bottom-dwelling juvenile. This stage has a distinctive appearance and is characterized by a flattened body and the presence of large swimming appendages. This phase is a critical

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period for dispersal and finding a suitable habitat for the adult.

129. (A) Summer spawning or sudden environmental stress
The growth rings on fish scales can sometimes show extra bands that do not represent a full year of life. These marks can be caused by unusual events like a sudden change in water temperature or the energy costs of spawning during the growing season. Scientists must be careful to identify these false marks to ensure they accurately estimate the age of the fish.

130. (A) I, II, III and V
The mathematical relationship between a fish's length and weight provides important information about its growth patterns and physical condition. A specific value in this equation indicates whether the fish is maintaining its shape, getting plumper, or becoming leaner as it grows. This index is a useful indicator of the overall health and environmental suitability for a population of fish in a given area.

131. (A) Catch curve
Fisheries scientists use a graphical technique to determine the total rate at which fish are removed from a population. By plotting the number of fish in different age or size groups, they can calculate the slope of the line that best fits the data. This value represents the combined effect of all causes of death, including natural mortality and losses due to fishing.

132. (A) Habitat carrying capacity limitations
In certain population models, the number of young fish joining the stock levels off as the adult population increases. This occurs because the available habitat and resources, such as food and nesting sites, can only support a certain number of individuals. This density-dependent factor ensures that the population does not exceed the environment's ability to provide for its members over the long.

133. (A) Diel vertical migration
Many aquatic animals perform a daily journey within the water column, moving toward the surface at night and descending to deeper waters during the day. This behavior is often driven by the need to find food while avoiding predators that rely on light to see. This widespread phenomenon is one of the largest synchronized movements of biomass on the planet, involving many species.

134. (A) Water velocity
Designing effective paths for fish to move past obstacles requires careful control of how quickly the water flows through the structure. If the current is too strong, many species will be unable to swim against it and will be prevented from reaching their upstream habitats. Providing areas with manageable flow speeds is the most critical factor for ensuring that fish can successfully navigate.

135. (A) It requires the sacrifice of the fish to detect the mark
One drawback of using certain chemicals to mark fish is that the mark can only be seen by examining the internal structures, such as the ear bones. This means that the fish must be killed before the information can be collected. While these marks are permanent and reliable, this requirement limits their use in studies where researchers want to track the same individuals.

136. (A) INCOIS
In India, a national agency is responsible for providing information about the most productive areas for fishing. By analyzing satellite data on ocean temperature and productivity, this organization generates daily maps and advisories for fishing communities along the coast. This service helps fishermen save time and fuel while improving their chances of a successful catch by targeting areas with high fish.

137. (A) Vessel Monitoring System (VMS)
Modern tools for managing fisheries include systems that provide real-time updates on the location of fishing boats. By comparing this information with radar data and official vessel registries, authorities can ensure that boats are operating legally and within their assigned areas. This spatial tracking capability is essential for protecting marine reserves and enforcing international fishing regulations across the world's oceans.

138. (A) Chelation of divalent cations to inhibit nucleases
During the process of extracting DNA, specific chemicals are added to protect the genetic material from being broken down by enzymes. One common additive binds to the metal ions

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that these enzymes need to function, effectively shutting them down. This step is critical for ensuring that the DNA remains intact and is of high enough quality for further molecular analysis and research.

139. (A) Water or sediment samples
Scientists can now identify the species present in an aquatic environment without ever actually seeing or catching them. By analyzing the tiny fragments of DNA that organisms shed into the water or sediment, researchers can create a complete list of the fish and other animals in the area. This non-invasive method is a powerful tool for monitoring biodiversity and detecting rare species.

140. (A) Both A and R are true and R is the correct explanation of A.
Highly variable genetic markers are excellent for determining the parents of individual fish in aquaculture or wild populations. These markers are found in many different versions, and because each individual inherits one version from each parent, they can be used to build accurate family trees. Their high level of variation and predictable inheritance patterns make them the gold standard for this type.

141. (A) Sardinella longiceps
The scientific name of a species follows a specific set of rules, including using italics and capitalizing only the first letter of the first name. The second part of the name is always written in lowercase. Following these international standards ensures that every species has a unique, universally recognized name that can be used by scientists and managers around the world without confusion.

142. (A) Temperature
The physical characteristics of a fish, such as the number of bones in its spine, can be influenced by the environment it experiences during its early development. Water temperature is a particularly important factor, as it can affect the rate of cell division and the formation of the basic body plan. This environmental influence can lead to variations between populations of the same species.

143. (A) Sympatric speciation
New species can sometimes evolve without any physical separation between populations. This can occur if a group begins to specialize on a different type of food or chooses a different time to reproduce, leading to reproductive isolation over many generations. This process allows two distinct lineages to emerge while still living in the same geographic area, driven by ecological and behavioral differences.

144. (A) Block polyspermy
Once a single sperm enters a fish egg, a rapid chemical reaction occurs on the egg's surface to prevent any other sperm from entering. This is a critical step because the entry of more than one sperm would lead to an incorrect number of chromosomes and prevent the embryo from developing properly. This immediate change ensures that the fertilization process is successful and.

145. (A) Mantle or visceral mass
In many bivalve molluscs, the reproductive organs are not separate, distinct structures but are instead embedded within the other tissues of the body. They are often found throughout the fleshy parts of the animal that contain the digestive and circulatory systems. As the eggs or sperm mature, these tissues can expand significantly, taking up much of the space within the shell before spawning.

146. (A) 11-ketotestosterone
Male teleost fishes produce a specific steroid hormone that is primarily responsible for the development of their reproductive organs and secondary sexual characteristics. This hormone also plays a key role in stimulating spawning behavior and the production of sperm. While other similar hormones are present, this specific chemical is the most important androgen for regulating reproduction in many common fish species.

147. (A) Unilateral eyestalk ablation
Aquaculturists often use a specialized technique to encourage female shrimps to produce eggs in captivity. By removing one of the structures that supports the eyes, they also remove the source of a hormone that naturally prevents maturation. This simple procedure lowers the levels of the inhibitory hormone in the shrimp's system, causing the ovaries to develop much more quickly than they would.

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148. (A) Active spawning
Fisheries biologists use a specific index to track the reproductive cycle of a fish population by comparing the weight of the gonads to the overall body weight. This value reaches its highest point just as the fish are ready to release their eggs and sperm. By monitoring this peak, researchers can accurately identify the main spawning season and set appropriate management.

149. (A) Gizzard
Many fish that consume tough plant material or algae have a specialized, thick-walled part of their stomach. This muscular structure uses powerful contractions and sometimes small swallowed stones to grind up the food, making it easier to digest. This adaptation is similar to the organ found in many birds and is essential for extracting nutrients from fibrous and low-energy aquatic plants.

150. (A) P-2, Q-1, R-2, S-3
The early life history of fishes involves several distinct stages, each with its own unique characteristics and nutritional needs. These stages range from newly hatched larvae that rely on their yolk sac for energy to fully developed juveniles that can feed and swim independently. Understanding these transitions is essential for studying the survival and growth of young fish in the wild or.

151. (A) Straight-hinge veliger
After the initial swimming stage, the larvae of many bivalve molluscs develop a simple shell with a characteristic shape. This early shell has a straight top edge, giving the larva a distinctive appearance under a microscope. This stage is a critical period in the development of clams, oysters, and their relatives, as they begin to grow the shells that will eventually.

152. (A) Otoliths
For species that live for many decades, some common ageing structures like scales may become unreliable because they can be damaged or partially reabsorbed by the body. The small calcified structures in the inner ear are much more stable and continue to grow throughout the fish's life, providing a complete and permanent record of every year. This makes them the preferred tool for.

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153. (A) K and L_∞
Scientists use a specialized graphical plot to estimate key growth parameters for a fish population. By plotting the length of a fish at one age against its length at a later age, they can calculate the maximum potential size and the rate at which that size is approached. These two values are fundamental to understanding the life history and productivity of the stock.

154. (A) Exploitation rate
Fisheries managers use a specific ratio to measure the intensity of fishing on a population. This value is calculated by dividing the rate of deaths due to fishing by the total rate of deaths from all causes. This simple index provides a quick way to assess if a population is being harvested too heavily and if the current levels of fishing are sustainable.

155. (A) Spawning stock biomass
This type of overfishing occurs when the adult population is reduced to such low levels that it can no longer produce enough young to replace itself. This leads to a steady decline in the number of new fish joining the fishery each year. Protecting the total mass of mature, reproducing individuals is the primary goal of many fisheries management plans to prevent.

156. (A) Catadromous
The European eel has a remarkable life cycle that involves a massive journey from freshwater rivers to a specific area in the Atlantic Ocean to spawn. After hatching in the sea, the larvae drift back to the coast and move into rivers to grow into adults. This migration between two very different environments is a defining characteristic of their biology and life history.

157. (A) Sustained burst swimming and jumping
Some structures designed to help fish move past dams require the animals to use a specific type of movement. To ascend a series of stepped pools, fish must be able to swim rapidly in short bursts and jump over the low walls between chambers. This design is most effective for species with strong swimming and jumping abilities, such as salmon and trout, during their.

158. (A) Electromagnetic field of the reader
Small electronic tags can be used to track individual fish without the need for an internal battery. These tags remain inactive until they

are brought close to a specialized reader, which generates a radio frequency field. This field provides the power needed for the tag to transmit its unique code, allowing researchers to identify the fish and record its movements over many years.

159. (A) Sea surface height anomalies and mesoscale eddies
Specialized satellites can measure the height of the ocean surface with extreme precision, revealing large-scale patterns and smaller, rotating current systems. These features are important because they can concentrate nutrients and plankton, attracting fish and other marine life. By mapping these anomalies, scientists can identify productive areas and track the movements of major ocean currents that influence fish distributions.

160. (A) III → II → I → IV
Shrimps undergo a series of dramatic morphological changes as they develop from a fertilized egg to a juvenile. This process involves several distinct larval forms, each with its own swimming and feeding strategies. Correctly identifying the sequence of these stages is essential for understanding the early life history of shrimps and for managing their production in commercial aquaculture hatcheries and nurseries.

161. (A) Flanking regions of the target DNA
In the process of copying specific DNA sequences, small pieces of genetic material are used to identify the exact section to be amplified. these fragments bind to the areas immediately surrounding the target sequence, providing a starting point for the copying enzyme. This precise binding ensures that only the desired part of the genome is multiplied, which is critical for accurate testing.

162. (A) DNA remains stable even after minor processing or freezing
Genetic techniques are powerful tools for identifying fish species even when they have been processed into fillets or other products. Because the DNA is a stable molecule that survives freezing and light cooking, it can be extracted and analyzed to verify the identity of the fish. This method is essential for detecting seafood fraud and ensuring that consumers get what they pay.

163. (A) Deviations indicating selection, migration, or non-random mating
Population genetics uses a specific model to predict how genetic variation should be distributed if no evolutionary forces are acting. By comparing the actual data from fish populations to this model, researchers can detect signs of interbreeding between groups, the effects of natural selection, or other factors that influence the genetic structure. This information is key to defining and managing distinct fish.

164. (A) Superfamily
In the hierarchical system used to classify all living things, specific suffixes are reserved for different levels of organization. For animals, a name ending with these six letters represents a group of related families. This level of classification helps scientists organize the vast diversity of fish into a clear and manageable structure, reflecting their shared evolutionary history and physical characteristics across broad groups.

165. (A) Body size (allometry)
When comparing the shapes of different fish, researchers must account for the fact that body proportions often change as an animal grows. For example, a juvenile may have a larger head relative to its body than an adult. Standardizing the data allows scientists to separate these growth-related changes from the actual differences in shape that distinguish one species or population from another.

166. (A) Sturgeons and some cyprinids
Certain groups of fishes have a natural tendency to possess extra sets of chromosomes, which can lead to the formation of new species without geographical separation. This phenomenon is particularly common in some very ancient lineages and certain families of freshwater fish. These extra chromosomes can provide a source of genetic variation that allows the species to adapt to new environments and challenges.

167. (A) Dense yolk granules
As fish eggs mature and prepare for spawning, they undergo a massive increase in size as they fill with nourishment for the future embryo. A close examination of the ovaries during this stage will reveal that the oocytes are packed with small, nutrient-rich particles. These granules

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provide the energy and building blocks needed for the developing fish larva after the egg is.

168. (A) Safe transfer of sperm to the female
Male cephalopods like squids and octopuses produce specialized packages that protect their sperm until it can be delivered to a female. These complex structures are often transferred using a modified arm during a synchronized mating behavior. Once inside the female, the package releases the sperm at the appropriate time to fertilize the eggs, ensuring that the genetic material is transferred successfully.

169. (A) Estradiol-17beta
The production of yolk in female fishes is triggered by a specific steroid hormone produced in the ovaries. This chemical signal travels through the bloodstream to the liver, where it stimulates the synthesis of the precursor protein that will eventually fill the developing eggs. This hormone is a central regulator of the reproductive cycle and is essential for producing high-quality eggs for spawning.

170. (A) III → I → II → IV
The process of shedding an old shell in crustaceans is triggered by signals from the environment, which lead to a cascade of hormonal changes. This involves a decrease in an inhibitory hormone from the eyestalk, followed by the release of a pro-molting hormone from a specialized gland. These chemical signals ensure that the animal only molts when conditions are right for growth.

171. (A) Exponential or power functional
As a fish grows larger, the number of eggs it can produce increases dramatically, often in a predictable mathematical pattern. This relationship means that a small increase in the length of a female can lead to a much larger increase in her potential reproductive output. This is why protecting large, older females is so important for the long-term health and recovery of stocks.

172. (A) Secretion of digestive enzymes and nutrient absorption
Many fish have small, finger-like pouches at the junction of their stomach and intestine. These structures serve to increase the internal surface area of the digestive tract, allowing the fish to more efficiently produce enzymes and absorb nutrients from its food. The number and size of these pouches vary between species and are closely linked to their specific diet and digestive needs.

173. (A) Anterior-posterior
During the early stages of a fish embryo's development, a specific cluster of cells forms that acts as a primary organizer for the body plan. This structure is essential for establishing the main axis of the body, defining which end will become the head and which will become the tail. This early pattern-setting is a critical step in the successful growth of the embryo.

174. (A) Antennae
In their early larval stage, certain marine invertebrates use their primary sensory appendages to both move through the water and gather food. These versatile structures are equipped with fine bristles that help the larva swim and trap microscopic particles. This dual-purpose adaptation is essential for the survival and growth of the young individual before it eventually settles and transforms into an adult.

175. (A) Somatic growth rate
The distinct bands seen on the small calcified structures in a fish's inner ear are caused by changes in how quickly the animal is growing. During periods of rapid growth, the rings appear different than during times of slow growth. Because these growth rates are often linked to seasonal changes in temperature and food, the rings can be used as a reliable record.

176. (A) Length-frequency analysis (e.g., ELEFAN)
Scientists can estimate how quickly fish are growing by monitoring the sizes of many individuals in a population over time. By looking at how the peaks in a size distribution shift from one sampling period to the next, they can calculate key growth parameters. This method is particularly useful for tropical species where traditional seasonal growth rings on scales or bones may be.

177. (A) The stock is likely overexploited
Fisheries managers use a specific ratio to assess the sustainability of a fishery by comparing the amount of fishing to the total number of deaths in the population. If this value exceeds a certain threshold, it indicates that more than half of the fish are being removed by human activity. This

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is often a signal that the population is being harvested too heavily.

178. (B) II only
Yield models are valuable tools for managing fisheries, but they have certain limitations and assumptions. One common model focuses on maximizing the catch from a group of young fish as they grow, but it does not account for the total biomass of the entire population or how the number of young fish changes with the size of the adult stock. Understanding these distinctions is critical.

179. (A) Olfactory imprinting
Migratory fish like salmon use their incredible sense of smell to find their way back to the exact stream where they were born. As juveniles, they learn the unique chemical signature of their home waters, and years later, they use this memory to navigate through the ocean and up rivers to spawn. This remarkable behavior is a key part of their complex life.

180. (A) Both A and R are true and R is the correct explanation of A.
Some fish passage structures are designed with a continuous vertical opening that allows water to flow through at a consistent depth. This design is highly effective because it provides a variety of conditions within the structure, allowing different species and sizes of fish to choose the path that best suits their swimming abilities. This flexibility makes it a versatile solution for diverse fish.

181. (A) Acoustic telemetry allows real-time or remote tracking without recapturing the fish
Tracking fish using sound waves offers a major advantage over traditional methods because the data can be collected remotely by underwater receivers. This means that researchers do not need to catch the fish again to get the information stored in the tag. This allows for continuous monitoring of fish movements and behavior over long periods, providing a more complete picture of their lives.

182. (A) Spatially referenced data
Modern mapping technology allows fisheries managers to combine many different types of information based on where they occur in the ocean. By layering data on fish abundance, habitat types, and fishing activity, they can create a comprehensive picture of the marine environment. This approach is essential for making informed decisions about where to establish protected areas and how to manage ocean resources.

183. (A) Illegal, Unreported, and Unregulated (IUU) fishing
International agreements help prevent illegal fishing by setting rules for how countries manage their ports. These measures allow authorities to inspect foreign vessels and deny entry or services to those suspected of breaking fishing laws. By closing off ports to illegal operators, these agreements make it much harder and more expensive to sell fish that were caught outside of legal regulations and management.

184. (A) High purity DNA
When scientists measure the quality of a genetic sample in the laboratory, they look at the ratio of light absorbed at two different wavelengths. A specific value indicates that the sample contains very few contaminants like proteins or chemicals from the extraction process. This high-quality DNA is essential for successful sequencing and other molecular tests that require a clean and stable starting material.

185. (A) Interspecific genetic distances being significantly larger than intraspecific distances
For DNA barcoding to be effective, there must be a clear difference in the genetic sequences between different species, but very little difference between individuals of the same species. This creates a measurable gap that allows scientists to accurately identify an unknown sample by comparing its DNA to a reference database. This property is what makes certain genetic markers so reliable for species identification.

186. (A) Principal Component Analysis (PCA)
Biologists use a powerful statistical tool to visualize the complex relationships between different groups of fish based on their genetic data. This method simplifies many variables into a few main dimensions, allowing researchers to see how much different populations overlap or vary. This type of analysis is essential for identifying distinct genetic stocks and understanding how they are related to each other geographically.

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187. (A) The single physical specimen designated to represent a new species
When a new species is described, one specific individual is chosen as the permanent reference for that name. This specimen is carefully preserved in a museum so that future scientists can examine it and compare it to other organisms. This official anchor ensures that the scientific name is always tied to a real, physical example of the species, providing a foundation for biological.

188. (A) Hypural plate or structural base of the caudal fin
Counting the scales along the side of a fish is a standardized procedure that follows specific anatomical landmarks. The count typically starts just behind the head and continues in a straight line toward the tail. It ends at the point where the fleshy part of the body stops and the tail fin begins, ensuring that the measurement is consistent across different individuals and species.

189. (A) Rate of nucleotide sequence mutation
Scientists can estimate when two different species of fish first evolved from a common ancestor by looking at the number of differences in their DNA. This approach is based on the idea that genetic mutations occur at a relatively steady rate over millions of years. By measuring these differences, researchers can build a timeline of evolutionary history and understand how biodiversity has changed.

190. (C) A is true but R is false.
Some fish have ovaries where all the eggs develop at the same time, meaning they are all released in a single spawning event. This strategy is common in species that only reproduce once in their lifetime or once per season. In these cases, the ovary does not contain multiple groups of eggs at different stages, but rather a single, uniform batch of maturing gametes.

191. (A) Encapsulating and protecting sperm during transfer
Male penaeid shrimps produce a specialized structure that houses their sperm until it can be delivered to a female. This protective package ensures that the delicate sperm cells are not lost or damaged in the water during the mating process. This mechanism is a key part of their reproductive strategy and is essential for the successful fertilization of eggs in the marine environment.

192. (A) Photoperiod and temperature changes
In many fish living in seasonal environments, the timing of reproduction is triggered by changes in the length of the day and the temperature of the water. These environmental cues are sensed by the fish and lead to the release of hormones that start the process of egg and sperm development. This ensures that spawning occurs when conditions are most favorable for survival.

193. (A) Blood glucose levels and repressing reproduction
A family of hormones produced in the eyestalks of crustaceans plays a dual role in managing their internal chemistry. These hormones help regulate the amount of sugar in the blood while also acting to prevent the reproductive organs from maturing too early. This complex control system ensures that the animal's energy is used for growth or reproduction at the appropriate stages of its life.

194. (A) Percentage of mature individuals
To determine when a fish population reaches maturity, scientists collect data on the size and reproductive state of many individuals. They then create a graph that shows how the proportion of mature fish changes as they get larger. The size at which half of the fish are mature is a key management parameter that helps ensure the population can replace itself for future.

195. (A) Capturing large discrete prey items
The shape and position of a fish's mouth, along with the structures in its gills, reveal how it finds and eats food. A mouth at the very front of the head and short, sturdy gill structures are common features of predatory fish that catch and swallow larger prey like other fish or crustaceans. These adaptations are essential for a successful carnivorous lifestyle in aquatic habitats.

196. (A) The animal pole
During the earliest stages of a fish embryo's growth, cell division is confined to a small area at the top of the large yolk mass. This concentrated growth leads to the formation of a disc of cells that will eventually become the body of the fish. This pattern of development is a characteristic of many fish species and is essential for the organized growth.

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197. (A) Appendage type used for swimming
Shrimp larvae undergo major changes in how they move through the water as they grow. Early stages often use their head appendages for swimming, while later stages develop specialized structures on their thorax for movement. These transformations are part of a complex life cycle that involves different feeding and swimming strategies at each stage, helping the young individual survive and grow in the ocean.

198. (A) Growth at the margins becomes too compressed to read on whole otoliths
For older fish that grow very slowly, the annual rings on their ear bones can become very crowded near the edge. This makes it difficult to count the rings accurately without cutting the bone into thin slices. Sectioning the structure allows scientists to see the growth patterns more clearly under a microscope, providing a much more reliable estimate of the fish's true age and.

199. (A) The theoretical maximum length a fish would reach if it lived indefinitely
Mathematical growth models used in fisheries science include a parameter that describes the upper limit of a fish's size. This value represents the average maximum length that individuals in a population would eventually reach based on their growth rate. It is a fundamental reference point for understanding the life history and productivity of a stock, helping managers set appropriate size limits for harvesting.

200. (A) P-4, Q-2, R-1, S-3
Fisheries scientists use various mathematical and statistical methods to estimate the different ways that fish are removed from a population. Some methods use the sizes of many fish, while others use empirical formulas based on growth and temperature. Mapping these parameters to their correct estimation techniques is essential for building accurate models of fish populations and managing them sustainably for the long.

201. (A) Density-independent juvenile survival rate
In population models, the number of young fish that successfully join the fishery is influenced by factors that are not related to the size of the population. These include environmental conditions like temperature and food availability, which can affect survival regardless of how many fish are present. This parameter determines how quickly the population can recover from low levels and is a key.

202. (A) Anadromous, catadromous, and amphidromous
Many fish species perform significant journeys between different environments as a regular part of their life cycle. These migrations can involve moving between freshwater and saltwater for spawning, feeding, or growth. This broad category of behavior includes several specific patterns of movement that allow fish to take advantage of the different resources and conditions found in marine, estuarine, and riverine habitats throughout their lives.

203. (A) Brush fishway
Some structures designed to help fish move past dams use an inclined path filled with many small, flexible obstacles. These features slow down the water and create a variety of different flow conditions that fish can navigate. This design is particularly effective for small or weak-swimming fish that might struggle with the strong currents and turbulence found in more traditional types of fishways.

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204. (A) Pop-up satellite archival tags (PSATs)
Advanced electronic tags can record the location, depth, and temperature of a fish's environment for many months. At a pre-programmed time, the tag detaches from the fish, floats to the surface, and transmits all the stored information to a satellite. This technology allows researchers to reconstruct the entire journey of the fish through the ocean without ever having to catch it again.

205. (A) Primary productivity and potential prey abundance
Identifying areas with high concentrations of fish often involves looking for signs of high productivity in the ocean. Satellites can detect the amount of microscopic algae in the water, which forms the base of the entire marine food web. Areas with high levels of these organisms attract small fish and other prey, which in turn draw in the larger predatory fish that are.

206. (A) Patrol vessels and aerial reconnaissance
Monitoring fishing activities and ensuring that regulations are followed requires active observation of the sea and the fishing fleet. Using boats and aircraft to patrol the waters allows authorities to identify and intercept vessels that

are operating illegally or in restricted areas. These physical presence and observation tools are fundamental to the surveillance part of a comprehensive fisheries management and control program.

207. (A) Maintaining a stable pH environment
During the laboratory process of isolating genetic material, it is critical to keep the chemical conditions stable. A specialized buffer is used to prevent the sample from becoming too acidic or too basic, which could damage the delicate DNA molecules. Maintaining the correct pH ensures that the DNA remains intact and is suitable for further testing and sequencing in subsequent research steps.

208. (A) Sequencing of individual amplicons
Modern genetic techniques have revolutionized species identification by allowing researchers to analyze many samples at once. Unlike traditional methods that require sequencing each piece of DNA separately, these high-throughput technologies can process thousands of sequences simultaneously. This significantly increases the speed and efficiency of biological research, making it possible to identify all the species in a complex sample like a stomach.

209. (A) Evolutionary gene flow and genetic drift
Scientists use genetic markers that are not influenced by natural selection to study the history and structure of fish populations. These markers reveal how genes have moved between different groups over many generations and how random events have shaped their genetic makeup. This information is essential for identifying distinct biological stocks and for developing management plans that protect the genetic diversity of species.

210. (A) I and III
The international rules for naming animals provide a consistent and stable framework for biological classification. These rules ensure that every species has a unique two-part name and use historical precedence to resolve any naming conflicts. Following these standards prevents confusion among scientists and managers worldwide, allowing for clear and effective communication about the world's biodiversity and the conservation of various aquatic.

211. (B) Geometric morphometrics
Advanced methods for analyzing body shape go beyond simple measurements of length and width. By tracking the positions of specific anatomical landmarks and using mathematical models to compare them, researchers can capture the entire geometry of a fish. This approach provides a much more detailed and accurate picture of how body shapes vary between different species, life stages, or populations in nature.

212. (A) Adaptive radiation
Sometimes a single ancestral species can rapidly evolve into many new species as they adapt to different ecological roles or environments. This process often occurs when a group moves into a new area with many available niches or after a major environmental change. This dramatic diversification is a key driver of biodiversity and has led to the incredible variety of fish found.

213. (A) Recent spawning
When fish release their eggs, the structures that supported those eggs remain in the ovaries for a short time. Biologists can identify these remnants under a microscope, providing a clear sign that the individual has recently spawned. This histological evidence is essential for confirming the timing of the reproductive cycle and for accurately identifying the peak spawning period of a population in the.

214. (A) The external molluscan shell
Some modern marine invertebrates possess an internal structure that is an evolutionary remnant of the hard outer shell found in their ancestors. This structure has been internalized and modified over millions of years, often becoming a lightweight, flexible rod that provides support for the animal's body. Understanding these evolutionary changes helps scientists trace the history and diversification of the molluscan family across different environments.

215. (A) Pars distalis
The brain of a fish controls reproduction through a direct connection to a specific part of the pituitary gland. Nerve cells in the brain produce a hormone that travels to this region, where it stimulates the release of other hormones that control the development of eggs and sperm. This precise neurological and hormonal pathway is the central regulator of the annual reproductive cycle.

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216. (A) Methyl farnesoate
Crustaceans possess a specialized organ that produces a hormone similar to one found in insects. this chemical messenger plays an important role in regulating various life processes, including the timing of molting and the maturation of the reproductive system. Studying the production and function of this hormone provides key insights into the complex physiology and growth patterns of shrimps, crabs, and lobsters.

217. (A) Hydration and ovulation
To get an accurate count of the number of eggs a fish produces, researchers must collect the ovaries before the final stage of maturation. During this final phase, the eggs rapidly take in water and are released from their supporting tissue, which can change their size and make them more difficult to count. Proper timing is essential for gathering reliable data on reproductive potential.

218. (A) Volume and frequency of occurrence
Biologists use a combination of different metrics to understand which prey items are most important in a fish's diet. By considering both how much space each item takes up in the stomach and how often it is found across many individuals, they can create a more balanced view of foraging behavior. This approach helps identify the primary sources of nutrition for a species.

219. (A) Organogenesis
After the initial stages of development, a fish embryo begins to form the building blocks for its future muscles and spine. This stage marks the beginning of the process where the specialized organs and tissues of the body start to take shape. The successful formation and organization of these early structures are essential for the proper development of the growing fish before it hatches.

220. (A) I and III
Crustaceans go through several distinct larval stages as they grow, each with its own unique anatomical features and movement patterns. Early stages often undergo multiple molts to increase in size and complexity, while later stages mark the final transition to the juvenile form. Understanding these different phases is critical for studying the early life history and dispersal of marine and freshwater crustaceans.

221. (A) Grinding and polishing the sagittal plane
To see the daily growth rings on the tiny ear bones of larval fish, researchers must carefully prepare the sample. This involves mounting the bone and using fine abrasives to wear it down to a thin, flat layer. This precise preparation allows the microscopic rings to be seen clearly under a high-power microscope, providing a detailed and accurate record of the larva's early life.

222. (A) Linear regression
The relationship between a fish's length and weight can be transformed into a straight line by using logarithmic values. Scientists then use a standard statistical technique to find the line that best fits the data, which allows them to calculate key parameters like the growth coefficient and condition factor. This method is a cornerstone of fisheries research for understanding the health and growth.

223. (A) Negative correlation
In fish populations, there is a general relationship between how large a species grows and its natural mortality rate. Species that reach a larger maximum size tend to have lower death rates from natural causes than smaller species. This pattern is part of the life history strategy of different fish, where larger size often provides better protection and a longer lifespan in nature.

224. (A) Ricker model
A specific population model assumes that the number of young fish joining the stock will eventually decrease at very high adult densities. This reduction is often attributed to intense competition or the consumption of young by adults. The model uses a mathematical function to describe how the recruitment rate changes, providing a tool for managers to predict the effects of different stock sizes.

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225. (A) Diel vertical migration
Many marine organisms perform a daily journey through the water column, moving toward the upper layers at night to feed and returning to deeper, darker waters during the day. This widespread behavior is one of the most significant migrations of biomass on Earth and involves many different species of fish and plankton. It is driven by the need to find food while avoiding.

226. (A) Turbulence and velocity
Designing effective structures to help fish move past dams requires creating areas where the water is not too fast or chaotic. If the current is too strong or irregular, many fish will be unable to swim through the structure and will be prevented from reaching their upstream habitats. Providing smooth, manageable flow is the most important factor for ensuring that fish can navigate successfully.

227. (A) Calcified structures like otoliths and scales
Some specialized dyes can be used to create a permanent, visible mark on the hard parts of a fish's body. When the fish is exposed to the dye, it is incorporated into the growing layers of the bones and scales. Under certain types of light, these marks glow, providing a clear and reliable way to identify groups of fish and study their growth.

228. (A) Low SST and high chlorophyll
Areas where cold, nutrient-rich water rises to the surface are key targets for fishing because they are highly productive. These regions show a distinctive signature in satellite data, with lower temperatures and higher concentrations of microscopic algae. This combination of signals identifies areas where the food web is thriving, attracting large numbers of fish and providing ideal conditions for successful fishing operations.

229. (A) Enacting licensing frameworks and gear regulations
Managing fisheries effectively requires a clear set of rules and a system for enforcing them. This involves setting limits on the number of fishing permits, the types of gear that can be used, and the areas where fishing is allowed. These regulatory measures provide the legal framework needed to control fishing activity and ensure that marine resources are harvested sustainably for the future.

230. (A) I, III and V
The laboratory process of copying DNA requires several key ingredients to be successful. These include the chemical building blocks of DNA, specialized ions that help the copying enzyme function, and a buffer to maintain a stable environment. Each of these components plays a critical role in ensuring that the target sequence is amplified correctly and provides enough material for research and testing.

231. (B) The COI universal primers
A standardized region of a mitochondrial gene is used for identifying animal species through DNA barcoding. The specific tools used to copy this region were designed by a pioneer in the field, making it possible to amplify the same gene from a vast range of different animals. This universal approach has been essential for building a global database of species and their genetic identities.

232. (C) Microsatellites
Certain genetic markers are particularly useful for identifying individual fish and their parents because they are highly variable and follow simple inheritance patterns. These markers are found throughout the genome and consist of repeating sequences that vary in length between individuals. Their reliability and high level of polymorphism have made them a gold standard for managing breeding programs and studying population structure in aquaculture.

233. (B) A specific type specimen or series of specimens
The formal naming of a biological species is based on a fundamental rule that links every name to a physical example. This individual is carefully preserved in a scientific collection to serve as a permanent reference for the species. This objective anchor ensures that the scientific name is always tied to a real organism, providing a consistent foundation for identification and biological research worldwide.

234. (A) Arabic numerals
In the systematic description of fish, standard symbols are used to record the number of different types of fin rays. One set of symbols is used for stiff, unbranched spines, while a different set is used for the flexible, branched rays. Following these conventions ensures that taxonomic descriptions are clear and can be easily understood and compared by researchers around the world without confusion.

235. (B) Short bursts of rapid speciation followed by long stasis
This evolutionary theory suggests that most species undergo very little change for long periods, with rapid bursts of evolution occurring over relatively short periods of time. These active phases are often associated with major environmental shifts or the colonization of new habitats. This view of the tree of life provides

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a different perspective on how biodiversity has developed and diversified throughout history.

236. (A) Fusion of yolk globules and massive influx of water
The final stage of development before a fish egg is released involves a dramatic increase in size. This process is characterized by the internal parts of the egg merging together and the uptake of a large amount of fluid. These changes make the egg transparent and buoyant, which are important adaptations for survival in the water column after the egg has been spawned.

237. (A) Seahorse (Syngnathidae)
Certain fish species have evolved unusual reproductive strategies where the male provides care for the developing eggs. In one specific family, males possess a specialized pouch on their abdomen where the female deposits her eggs. The male then protects and nourishes the embryos until they are ready to hatch, demonstrating a remarkable example of parental care and specialized adaptation in the aquatic environment.

238. (A) It acts as the primary maturation-inducing steroid
A specific steroid hormone plays a critical role in the final maturation of both eggs and sperm in many fish species. This chemical signal triggers the final changes needed for fertilization to occur and is a key regulator of the spawning process. Understanding the role of this hormone is essential for studying the reproductive physiology of fish and for managing their production in aquaculture.

239. (C) Gonad-inhibiting hormone
Removing a specialized endocrine structure in crustaceans eliminates the source of several important hormones. One of these hormones naturally prevents the reproductive organs from maturing, so its removal allows the ovaries to develop more quickly. This surgical procedure is often used in aquaculture to induce spawning in female shrimps and crabs, helping to provide a steady supply of young for commercial operations.

240. (A) Both A and R are true and R is the correct explanation of A.
Fisheries biologists use a specific index to track the reproductive cycle of a fish population by comparing the weight of the gonads to the overall body size. This value increases significantly as the reproductive organs grow in preparation for spawning. By monitoring these changes, researchers can identify the main breeding season, which is essential for managing fish stocks and protecting them.

241. (A) Carnivorous
The anatomy of a fish's digestive tract is closely linked to its primary source of nutrition. Species that primarily consume other animals typically have a relatively short and simple intestine because animal tissue is nutrient-dense and easy to process. A ratio of gut length to body length within this specific range is a definitive morphological indicator of a predatory or meat-based diet.

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242. (A) Left-right asymmetry
During the early development of a fish embryo, a transient structure forms that is essential for setting the basic body plan. This small vesicle plays a key role in determining which organs will be placed on the left or right side of the body. The successful function of this early organizer is critical for the proper development of the internal organs and systems.

243. (A) Molluscs
Many aquatic invertebrates share a similar larval stage characterized by a ring of cilia used for swimming and feeding. This free-swimming form is found in several different groups, including various types of worms and many species of snails and clams. This common developmental phase reflects a shared evolutionary history among these diverse groups of marine and freshwater organisms throughout their life cycles.

244. (A) The labyrinth organ
Fish possess small, calcified structures in their inner ears that are housed within a specialized sensory system. This system is responsible for detecting sound and maintaining balance, and the hard structures play a key role in this process. Because these structures grow throughout the fish's life and deposit regular layers, they are also valuable tools for scientists studying the age and growth.

245. (A) Rn (goodness of fit index)
Scientists use specialized computer programs to estimate fish growth by analyzing the sizes

of many individuals in a population. These algorithms test many different growth patterns to find the one that best matches the actual data. A specific statistical score is used to measure the quality of this match, ensuring that the resulting growth model is as accurate and reliable as possible.

246. (A) Fish size or biomass
Underwater sound technology is used to estimate the abundance of fish by measuring how much sound is reflected back to a receiver. The strength of this reflected signal is related to the size of the individual fish, providing a way to estimate the total weight of a school without catching them. This non-invasive method is a powerful tool for monitoring fish populations.

247. (A) At a lower effort level than MSY
Managing a fishery for the greatest possible profit requires a different approach than simply trying to catch the most fish. The point of maximum economic benefit typically occurs at a lower level of fishing intensity than the point of maximum sustainable catch. This is because reduced fishing effort lowers costs and can lead to larger, more valuable fish in the population over time.

248. (A) Thermal fronts and food
Large oceanic fish like tunas perform massive, synchronized journeys across the world's oceans in search of optimal conditions. These migrations are primarily driven by the need to find productive areas with high concentrations of prey, which are often found along the boundaries between different water masses. By tracking these features, tuna can maximize their growth and energy intake throughout the year.

249. (A) Rock-ramp fishway
Some structures designed to help fish move past dams use a natural-looking path filled with stones and boulders. This design creates a gently sloping channel with many small pools and resting areas, simulating the conditions found in natural rapids. This type of fishway is effective for a wide range of species and sizes, as it provides a manageable way to ascend.

250. (A) P-3, Q-4, R-2, S-1
Researchers use a variety of different tags and marks to identify individual fish and track their movements. Some tags use sound waves, while others rely on radio signals or simple visual marks. Mapping these different techniques to their specific characteristics is essential for choosing the right tool for a research study and for accurately interpreting the data collected from tagged fish in nature.

251. (B) Obstruction by dense cloud cover
Satellite technology provides a powerful way to monitor the ocean surface, but it has some practical limitations. Sensors that use visible light cannot see through thick clouds, which can lead to data gaps during certain seasons or in cloudy regions. This makes it difficult to provide continuous information about ocean productivity and temperature, which are essential for identifying the best areas for fishing.

252. (A) No, it is strictly a voluntary instrument
The international community has developed a set of guidelines to encourage the responsible and sustainable management of the world's fisheries. While these rules provide an important framework for national laws and policies, they are not legally binding on their own. Instead, they serve as a shared vision for how fisheries should be managed to protect marine resources and the communities that rely on them.

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253. (A) Sodium dodecyl sulfate (SDS)
During the process of isolating DNA from biological samples, it is necessary to break open the cells to release the genetic material. A specialized chemical is used to dissolve the fatty membranes that surround the cells and their nuclei. This step is critical for making the DNA accessible for further purification and analysis in the laboratory, ensuring a clean and stable sample for research.

254. (A) Illumina Sequencing
Modern genetic research relies on powerful technology that can read millions of DNA sequences simultaneously. This high-speed approach has revolutionized the study of biodiversity and the management of fish stocks by making it much faster and cheaper to gather vast amounts of genetic data. This technology is now a standard tool for scientists around the world, from identifying species to managing breeding programs.

255. (A) They are ubiquitous and easily automated for genome-wide screening
Certain genetic markers are favored for large-scale studies because they are found in extremely high numbers throughout the entire genome. These simple, single-base variations can be analyzed quickly using automated systems, allowing researchers to gather data on thousands of markers across many individuals. This high-resolution view of genetic variation is a powerful tool for studying the population structure and history of species.

256. (A) When the original holotype is lost or destroyed
In cases where the original physical reference for a species is no longer available, a new specimen must be chosen to take its place. This ensures that the scientific name remains tied to a real, physical example that can be examined by future researchers. This replacement process follows strict international rules to maintain stability and consistency in biological nomenclature and species identification worldwide.

257. (A) Lateral line scales
Counting the specialized scales along the side of a fish is a standard procedure for identifying different species. These scales contain sensory structures that help the fish detect movement and vibrations in the water. Because the number of these scales is determined early in life and does not change as the fish grows, it provides a reliable and objective way to distinguish between species.

258. (A) Explicit mathematical models of nucleotide sequence evolution
Building accurate models of the evolutionary relationships between different species requires using complex mathematical and statistical tools. These methods analyze DNA sequences and look for the most likely patterns of change over millions of years. By testing different evolutionary scenarios, scientists can build a more robust and reliable picture of the tree of life and how different groups of fish are related.

259. (A) Granulosa cells
When a fish does not release all of its eggs, the remaining ones are broken down and reabsorbed by the body. Specialized cells within the ovary grow larger and actively work to digest the yolk and other materials in the unspawned eggs. This recycling process is a natural part of the reproductive cycle and helps the fish recover energy for future spawning events.

260. (A) Gravity and spatial orientation
Many aquatic invertebrates have a specialized organ that helps them sense their position in the water and the pull of gravity. This structure contains a small, hard particle that moves as the animal tilts, stimulating sensory cells and providing information about its orientation. This sense is essential for maintaining balance and for performing daily vertical movements or finding a suitable place.

261. (A) Glycoproteins
The hormones that control reproduction in fishes are complex molecules made of proteins and sugars. These chemical messengers are produced in the pituitary gland and travel through the bloodstream to the ovaries or testes, where they trigger the development of eggs and sperm. Their unique structure is essential for their function as key regulators of the annual reproductive cycle in all fish species.

262. (A) Conversion to active hormone
The process of molting in crustaceans is regulated by a steroid that must be transformed into a different version before it can trigger the shedding of the old shell. Once secreted, this precursor molecule is modified in the body tissues to become the active signal that starts the complex physiological changes needed for growth. This two-step process ensures that molting occurs only when needed.

263. (A) Total weight
The number of eggs a fish produces is often more closely related to its total mass than its length alone. Larger, heavier fish generally have more energy and space to devote to reproduction, leading to a much higher potential catch. Understanding this relationship is important for estimating the total reproductive output of a population and for developing management plans that protect the most productive.

264. (A) Active spawning or intense migratory phase
Finding many fish with empty stomachs can provide important clues about their life history and behavior. Some species stop feeding altogether during their main breeding season or when they are performing long-distance

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journeys. These physiological states can be identified by monitoring the contents of the digestive tract, helping researchers understand the seasonal patterns and energy requirements of fish populations in their natural habitats.

265. (A) Formation of the blastocoel
The early development of a fish embryo involves a transition from a solid ball of cells to a hollow structure. This change marks the end of the initial stage of rapid cell division and the beginning of the phase where the body layers will start to form. The appearance of this fluid-filled cavity is a key landmark in the successful growth of the embryo.

266. (A) Zoea
The larvae of certain freshwater prawns must spend part of their lives in brackish water to survive and grow. This stage is a critical period in their development, as they are not yet able to handle the low salinity found in freshwater rivers. Understanding these environmental requirements is essential for managing the production of these prawns in hatcheries and for protecting their natural habitats.

267. (A) Calcein or Oxytetracycline
Researchers use specialized chemical markers to verify the timing of the growth rings on fish ear bones. By exposing the fish to the dye at a known time, they create a permanent mark that can be seen later under a microscope. This allow them to confirm how many rings are deposited each day or year, providing a reliable foundation for estimating fish age.

268. (A) It significantly decreases
The constant in the length-weight relationship is an indicator of the overall physical state of a fish population. In a poor environment with limited food, fish may become much leaner, leading to a lower value for this parameter. Monitoring these changes over time can provide early warnings about the health of the population and the suitability of the habitat for supporting sustainable growth.

269. (A) Age classes
Analyzing the changes in a fish population over time requires organizing the data into groups based on their age. By tracking each group from the time they hatch until they leave the fishery, scientists can estimate key parameters like mortality and recruitment. This approach is fundamental to understanding how the population responds to fishing and for setting sustainable harvest levels for the long.

270. (A) Age or size at first entry into the exploitable fishery
Fisheries models use a specific term to describe the number of young fish that survive long enough to be caught by the fishing fleet. This is an important milestone because it marks the point where the fish begin to contribute to the total catch and the productivity of the fishery. Understanding how this number varies from year to year is essential for managing fish stocks.

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271. (A) Freshwater systems
Some fish species perform significant journeys within rivers and lakes but never enter the ocean or estuaries. These migrations are often driven by the need to find optimal spawning grounds or more productive areas for feeding and growth. This pattern of movement is a key part of their life history and reflects the diverse ways that fish use their freshwater habitats throughout their lives.

272. (A) Proportion of successful ascent
The performance of a fish passage structure is measured by how many fish that arrive at the bottom actually make it to the top. This simple ratio provides a direct estimate of how effective the structure is at helping fish overcome dams and other barriers. Monitoring this success rate is essential for improving the design of fishways and ensuring that migratory species can reach.

273. (A) Detach and transmit to satellite
Advanced electronic tags are designed to record data on a fish's movements and environment for several months. At the end of the study, the tag releases itself from the fish and floats to the surface, where it sends all its stored information to a satellite. This allows researchers to gather detailed data on the lives of marine animals without having to catch them again.

274. (A) Thermal infrared and microwave
Specialized satellite sensors are used to measure the temperature of the ocean surface, which is a key factor in identifying productive fishing areas. These sensors can detect heat patterns and even see through clouds, providing a continuous picture of the ocean environment. Mapping these

temperatures helps scientists and fishermen find areas with the right conditions for different fish species to aggregate for feeding.

275. (A) Control
Managing a sustainable fishery requires a clear legal framework and a system for regulating fishing activity. This involves setting rules for who can fish, where they can operate, and what gear they can use. These administrative and legal tools are essential for managing the total harvest and ensuring that marine resources are protected for future generations in accordance with national and international laws.

276. (A) To separate and verify the size of the amplified DNA fragments
After copying specific DNA sequences in the laboratory, it is necessary to check if the reaction was successful. A common method involves using an electric field to move the DNA through a gel, which separates the fragments based on their size. This allow researchers to see if the correct piece of DNA was amplified and to estimate its length, which is a key.

277. (A) DNA barcode sequences and associated voucher data
A specialized global database is used to store and analyze the genetic sequences used for identifying animal species. This resource provides researchers with access to thousands of reference sequences and information on the physical specimens they came from. This collaborative platform is essential for building a comprehensive library of life and for using DNA barcoding to study and protect the world's biodiversity.

278. (A) Significant loss of genetic diversity and heterozygosity
When a population is suddenly reduced to a very small number of individuals, it can lose much of its genetic variation. This can happen due to overfishing, disease, or a major environmental event. The remaining group may not have the genetic tools needed to adapt to future challenges, which can threaten the long-term survival and recovery of the population even if its numbers increase.

279. (A) Any specimen from the type series other than the holotype
When a new species is described, the scientists often designate several specimens as the official reference for the name. While one individual is chosen as the primary reference, the others also play an important role in documenting the variation within the species. These additional specimens are carefully preserved in scientific collections to provide a complete picture of the new species for future researchers.

280. (A) Branchial arches
Counting the bony structures that support the gills is a standard method for identifying different fish species. These arches provide the framework for the respiratory system and their number is a stable and objective trait that does not change throughout the fish's life. This meristic character is a key part of the systematic description of fish and is essential for accurate taxonomic identification.

281. (A) Autapomorphy
In the study of evolutionary relationships, some traits are found in only one specific group and nowhere else. These unique, derived characteristics provide evidence for the independent evolution of that group and are essential for building accurate models of the tree of life. Identifying these traits helps scientists distinguish between different lineages and understand the specific changes that have occurred over evolutionary time.

282. (A) Polyspermy
Once a single sperm enters a fish egg, a rapid change occurs on the surface of the egg to prevent any others from entering. This immediate reaction is essential because the entry of more than one sperm would result in an incorrect number of chromosomes and prevent the embryo from developing properly. This ensures that the fertilization process is successful and the offspring is healthy.

283. (A) Elasmobranchs and cephalopods
Certain marine animals have specialized organs that are responsible for creating protective cases for their eggs. These glands produce a tough, durable material that protects the developing embryos from predators and environmental stress. This reproductive strategy is common in squids and octopuses as well as sharks and rays, reflecting the diverse ways that different groups have evolved to protect their young in the ocean.

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284. (A) Growth Hormone-Releasing Hormone (GHRH)
The brain produces a specific hormone that triggers the release of other chemicals responsible for growth. In many fish species, this hormone also plays a role in regulating the timing of reproduction, as growth and maturation are closely linked processes. Understanding these complex hormonal interactions is essential for studying the life history of fish and for managing their production and health in aquaculture operations.

285. (A) Genetic sex determination
In many crustaceans, the development of male characteristics is controlled by a specialized endocrine organ. The hormones produced by this gland are so powerful that they can determine the individual's sexual traits regardless of its underlying genetic makeup. This unique system allows for a remarkable degree of flexibility in sexual development and is a major focus for scientists studying the physiology and growth of shrimps.

286. (A) $L_{\{50\}}$
Fisheries biologists use a specific value to identify the size at which a significant portion of a fish population has reached sexual maturity. This is the length at which half of the individuals are capable of reproducing. This measurement is critical for setting sustainable fishing limits and for ensuring that the population can replace itself, helping to maintain the spawning stock for future generations.

287. (A) Gastric evacuation rate
Researchers measure how quickly food is moved through the digestive tract to understand the nutritional needs and foraging behavior of fish. This rate determines how often a fish needs to eat and how much energy it can extract from its prey. This information is essential for building accurate models of fish growth and for understanding the ecological role of different species in habitats.

288. (A) Migration of one eye to the opposite side of the head
Flatfishes undergo a remarkable transformation as they develop, with one eye moving across the top of the head to join the other on the opposite side. This results in an asymmetrical adult that lives on the seafloor, perfectly adapted for its bottom-dwelling lifestyle. This dramatic morphological change is a defining characteristic of their biology and one of the most unusual adaptations in the kingdom.

289. (A) Barnacles
Certain marine invertebrates have a unique larval stage that is specialized for finding and settling on a suitable surface. This stage has a distinctive appearance with a two-part shell and is equipped with powerful organs for attachment. Once it finds a good location, it undergoes a final transformation into a permanent adult, marking the end of its free-swimming life in the water column.

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290. (A) Sagittal or transverse plane
To see the internal growth rings of a fish ear bone, it must be cut in a specific direction. Cutting along these planes provides a clear view of the layers that have been deposited throughout the fish's life, allowing scientists to count the rings and estimate the age. This standardized approach ensures that age estimates are consistent and accurate across different individuals and fish species.

291. (A) t_0
Mathematical growth models include a parameter that accounts for the fact that fish are already a certain size when they are born. This value represents the theoretical time when the fish would have been zero length based on its later growth rate. It is an important adjustment factor that helps the model more accurately reflect the real-world growth patterns of a fish population over time.

292. (A) Decreasing population abundance
A steady decline in the amount of fish caught for each unit of fishing effort is often a sign that the population is becoming less abundant. This simple indicator provides fisheries managers with a way to track the health of a fish stock and to identify when harvest levels may be too high. Monitoring these trends is essential for making informed decisions about management.

293. (A) Schaefer
This population model describes how the maximum sustainable catch can be calculated from the relationship between fishing effort and total yield. It assumes that the population has a natural capacity to grow and that this growth

is highest at a moderate population size. By targeting this point, managers can optimize the productivity of the fishery while ensuring that the stock remains healthy.

294. (A) Autumn moon and low temperature
The timing of migration in certain fish species is triggered by a combination of environmental cues, such as seasonal changes in light and temperature. These signals ensure that the fish move to their spawning grounds when conditions are most favorable for the survival of their offspring. This synchronized behavior is a key part of their life history and reflects their deep connection to cycles.

295. (A) Fish lock
Some structures designed to help fish move past dams work like a water elevator. Fish are encouraged to enter a chamber, which is then sealed and filled with water to lift them to the level of the upstream reservoir. This design is particularly effective for high dams where more traditional fish passage structures might be too difficult for many species to navigate successfully on their.

296. (A) They provide only point-to-point data (release and recapture locations)
Simple physical tags offer a major advantage in terms of cost and ease of use, but they provide limited information about a fish's life between the time it was tagged and the time it was caught again. Unlike advanced electronic tags that can record a continuous record of movement and environment, these tags only tell researchers where the fish started and where it finally ended.

297. (A) Thermal fronts and eddies
Identifying areas where different water masses meet is key for finding high concentrations of fish. These oceanographic features act as natural boundaries that can concentrate nutrients and plankton, attracting large numbers of prey and the predators that eat them. By mapping these fronts and rotating current systems, scientists can identify productive fishing zones and track the movements of many different pelagic fish species.

298. (A) Output controls
Managing a fishery can involve setting limits on the total amount of fish that can be harvested each year. This type of regulation focuses on the final result of fishing activity rather than the amount of effort or gear used. By setting an overall quota, managers can ensure that the total catch remains within sustainable limits and that the fish population is protected for the.

299. (A) Automate temperature shifts
The laboratory process of copying DNA involves a repeating cycle of heating and cooling, which is essential for separating the DNA strands and synthesizing new ones. A specialized machine is used to automate these temperature changes with high precision, ensuring that each step of the reaction occurs at the optimal time and temperature. This tool has made genetic research much faster and more reliable.

300. (A) Interspecific gene transfer
Genetic introgression is the transfer of genes from one species into another through hybridization followed by repeated backcrossing. It is commonly measured using nuclear genetic markers because they reflect contributions from both parents. Introgression plays an important role in evolution, adaptation, biodiversity, and conservation genetics.

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CHAPTER 03
Fish Stock Assessment

1. 2004
Which term specifically describes the total weight of a fish population in a given area?
(A) Biomass
(B) Abundance
(C) Yield
(D) Unit stock

2. 2003
A fish stock that migrates across multiple Exclusive Economic Zones but not into the high seas is classified as:
(A) Straddling stock
(B) Highly migratory stock
(C) Transboundary stock
(D) Mixed stock

3. 2016
Compared to temperate fisheries, tropical multi-species fisheries are generally characterized by:
(A) Continuous spawning and rapid growth
(B) Lower biodiversity and long lifespans
(C) Seasonal spawning and slow growth
(D) Single-species dominance and high natural mortality

4. 2007
In traditional morphometrics, which measurement is most vulnerable to distortion during specimen preservation?
(A) Head length
(B) Standard length
(C) Predorsal length
(D) Total body weight

5. 2022
Which elemental ratio in otolith microchemistry is most commonly used to reconstruct temperature history?
(A) Barium:Calcium
(B) Strontium:Calcium
(C) Magnesium:Calcium
(D) Zinc:Calcium

6. 2016
Mitochondrial DNA (mtDNA) is preferred over nuclear DNA in certain genetic stock identifications primarily because:
(A) It exhibits biparental inheritance
(B) It codes for a larger number of phenotypic traits
(C) It has a higher mutation rate and lacks recombination
(D) It is highly conserved and identical across all species

7. 2011
Catch per Unit Effort (CPUE) is most strictly defined as an index of:
(A) Fishing mortality
(B) Natural mortality
(C) Maximum sustainable yield
(D) Population abundance

8. 2002
In the length-weight relationship $W = aL^b$, isometric growth is indicated when the value of b is exactly:
(A) 2.0
(B) 2.5
(C) 3.5
(D) 3.0

9. 2024
Age determination using scales is often unreliable in older fish of long-lived species primarily due to:
(A) High calcium carbonate deposition rates
(B) Resorption and compaction of annuli at the edge
(C) Rapid continuous growth in later life stages
(D) Loss of scales during capture

10. 2021
Read the given assertion and reason, then select the correct option.
Assertion (A): The von Bertalanffy parameter t_0 represents the theoretical age when a fish has a length of zero.
Reason (R): t_0 is always a positive value in fast-growing pelagic fish species.
(A) Both A and R are true and R is the correct explanation of A.
(B) A is true but R is false.
(C) A is false but R is true.

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(D) Both A and R are true but R is not the correct explanation of A.

2019

11. The exploitation rate (E) in a fished population is mathematically defined as:
(A) $\frac{F}{Z}$
(B) $F + M$
(C) $\frac{M}{Z}$
(D) $\frac{Z}{F}$

2009

12. Which parameter is NOT required in Pauly's empirical equation for estimating natural mortality (M)?
(A) Mean environmental temperature
(B) Asymptotic length (L_∞)
(C) Spawning stock biomass
(D) Asymptotic weight (W_∞)

2023

13. The Ricker stock-recruitment curve differs from the Beverton-Holt curve primarily by incorporating:
(A) Constant recruitment at all stock sizes
(B) Linear increases in recruitment
(C) Density-independent mortality solely
(D) Overcompensatory density dependence

2018

14. Which factor is considered density-independent in regulating fish populations?
(A) Competition for food
(B) Intraspecific predation
(C) Sudden temperature fluctuations
(D) Disease transmission rates

2009

15. The length at which 50% of the fish encountering a fishing gear are retained is denoted as:
(A) L_∞
(B) $L_{\{50\}}$
(C) $L_{\{opt\}}$
(D) L_m

2004

16. The Schaefer surplus production model assumes that the relationship between yield and effort is:
(A) Exponential
(B) Asymptotic
(C) Logarithmic
(D) Parabolic

2015

17. The Beverton and Holt Yield-per-Recruit model assumes that fishing mortality is:
(A) Constant above the age of first capture
(B) Continuously increasing with age
(C) Decreasing logarithmically with size
(D) Zero at all ages

2007

18. Pope's cohort analysis provides a simplification of Virtual Population Analysis (VPA) by assuming that:
(A) Natural mortality is zero
(B) Fishing mortality is constant across all age groups
(C) Catch is taken exactly halfway through the year
(D) Growth is linear throughout the lifespan

2023

19. Maximum Economic Yield (MEY) typically occurs at a level of fishing effort that is:
(A) Equal to the effort at Maximum Sustainable Yield (MSY)
(B) Greater than the effort at MSY
(C) Less than the effort at MSY
(D) Completely unrelated to MSY

2019

20. Match the fishery reference points in List I with their definitions in List II.
List I: (Reference Point)
P. Limit Reference Point
Q. Target Reference Point
R. $F_{\{\max\}}$
S. $F_{\{0.1\}}$
List II: (Definition)
1. Desired optimal state of the fishery
2. Maximum yield per recruit fishing mortality
3. State to be avoided to prevent collapse
4. Marginal yield is 10% of origin
(A) P-1, Q-3, R-2, S-4
(B) P-3, Q-2, R-1, S-4
(C) P-1, Q-4, R-3, S-2
(D) P-3, Q-1, R-2, S-4

2023

21. The classic Lotka-Volterra equations primarily model which type of interspecific relationship?
(A) Mutualistic symbiosis
(B) Predator-prey dynamics
(C) Commensalism
(D) Parasitism

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2022
22. In ECOPATH modeling, the fundamental assumption of mass-balance requires that:
(A) Production exceeds consumption for all groups
(B) Total biomass increases exponentially
(C) Production equals consumption plus mortality and export
(D) Fishing mortality is zero

2009
23. Length-Based Spawning Potential Ratio (LB-SPR) is primarily utilized in scenarios where:
(A) Extensive age-structure data is available
(B) Only catch data is missing while effort is precise
(C) Ecosystem-wide trophic interactions are known
(D) Data is limited to length frequencies and life history

2015
24. Which algorithm within the FiSAT II software package is specifically designed for extracting growth parameters from length-frequency data?
(A) ELEFAN
(B) VPA
(C) Y/R analysis
(D) Catch curve

2018
25. An aggregation of fish exhibiting similar life history characteristics and random mating is defined as a:
(A) Metapopulation
(B) Unit stock
(C) Cohort
(D) Sub-species

2011
26. Highly migratory stocks, such as tunas, are primarily governed under which international framework?
(A) CITES
(B) UNCLOS
(C) CBD
(D) MARPOL

2011
27. A key challenge in applying temperate stock assessment models to tropical fisheries is the:
(A) Lack of clear seasonal growth rings on hard parts
(B) Extremely slow growth rates of tropical fish
(C) Complete absence of multiple species
(D) Excessively high abundance of single species

2017
28. Truss network analysis improves upon traditional morphometrics by:
(A) Utilizing genetic markers instead of physical measurements
(B) Focusing exclusively on otolith shape
(C) Providing a two-dimensional geometric shape representation
(D) Measuring weight variations over time

2014
29. Otolith shape analysis is particularly useful for stock delineation because otolith shape is:
(A) Solely determined by diet
(B) Constant across all age classes
(C) Completely unrelated to genetics
(D) Genetically fixed and environmentally modified

2011
30. Consider the following statements about microsatellite markers:
I. They are short tandem repeats.
II. They exhibit low mutation rates.
III. They are highly polymorphic.
Which of the above statement(s) is/are correct?
(A) I and II
(B) I and III
(C) II and III
(D) I, II and III

2007
31. Fishery-independent surveys are generally preferred for abundance indices because they:
(A) Rely on commercial logbooks
(B) Standardize sampling gear and randomized design
(C) Suffer from localized depletion bias
(D) Are significantly cheaper than fishery-dependent methods

2002
32. Fulton's condition factor (K) is mathematically expressed as:
(A) $K = \frac{W}{L^2} \times 100$
(B) $K = \frac{L}{W^3} \times 100$
(C) $K = \frac{L}{W} \times 100$
(D) $K = \frac{W}{L^3} \times 100$

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2012
33. The relative condition factor (K_n) is specifically designed to account for:
(A) Variations in growth purely due to age
(B) Differences between empirical weight and theoretical expected weight for a given length
(C) Genetic mutations in weight
(D) Standardizing length across different species

2017
34. Length-frequency analysis is most effective for estimating age in species that exhibit:
(A) Continuous, year-round spawning
(B) Extreme longevity with no distinct cohorts
(C) Highly restricted and discrete spawning seasons
(D) Extremely high mortality rates in early stages

2005
35. In the von Bertalanffy Growth Function, the parameter K represents the:
(A) Rate at which length approaches the asymptote
(B) Maximum length achievable by the fish
(C) Natural mortality rate
(D) Age at length zero

2024
36. Which parameter combination represents the correct relationship for total mortality (Z)?
(A) $Z = M - F$
(B) $Z = F - M$
(C) $Z = \frac{M}{F}$
(D) $Z = M + F$

2006
37. Hoenig's empirical method for estimating natural mortality (M) primarily utilizes:
(A) Asymptotic length
(B) Maximum observed age
(C) Environmental temperature
(D) Growth coefficient

2014
38. A linearized catch curve is plotted as the natural logarithm of:
(A) Catch against length
(B) Catch per unit effort against age
(C) Catch per unit age against age
(D) Total biomass against age

2013
39. In the Beverton-Holt stock-recruitment model, recruitment approaches an asymptote due to:
(A) Allee effects at high densities
(B) Cannibalism of juveniles by adults
(C) Decreased fecundity of older females
(D) Starvation and competition for limited resources

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2010
40. Consider the following assumptions for the Schaefer surplus production model:
I. Population growth follows a logistic curve.
II. Catchability (q) remains constant.
III. It accounts for age-structured dynamics.
IV. Immediate response to environmental changes.
Which of the above statement(s) is/are correct?
(A) I, II and III
(B) II, III and IV
(C) I, III and IV
(D) I, II and IV

2004
41. A logistic selection curve for a trawl net is mathematically defined by the probability of:
(A) Encounter given the depth of the gear
(B) Retention given the length of the fish
(C) Survival after passing through the mesh
(D) Spawning after escaping the net

2021
42. The Fox surplus production model uses which type of relationship between CPUE and fishing effort?
(A) Linear
(B) Exponential
(C) Polynomial
(D) Asymptotic

2015
43. The Thompson and Bell analytical model differs from the Beverton and Holt Y/R model primarily by:
(A) Utilizing age- or length-specific arrays for modeling
(B) Ignoring the economic value of the catch
(C) Assuming constant growth and mortality across all ages
(D) Operating solely on biomass aggregates

2012
44. In Virtual Population Analysis (VPA), calculations proceed in which direction?
(A) Forward from the youngest age to the oldest
(B) Backward from the oldest age class to the youngest
(C) Concurrently across all age classes simultaneously

(D) Randomly among selected age cohorts

2024

45. Maximum Sustainable Yield (MSY) represents the point on a production curve where:
(A) Total biomass is at carrying capacity
(B) Economic rent is maximized
(C) Fishing mortality is minimized
(D) Surplus production is maximized

2013

46. Biological Reference Points (BRPs) based on fishing mortality, such as $F_{\{0.1\}}$, are formulated to prevent:
(A) Environmental degradation
(B) Natural mortality fluctuations
(C) Growth overfishing
(D) Habitat destruction

2016

47. Multispecies VPA (MSVPA) expands single-species VPA primarily by calculating:
(A) Economic variations in multi-gear fleets
(B) Predation mortality (M_2) internally
(C) Density-independent mortality factors
(D) Spawning stock biomass of non-target species

2014

48. In an ECOPATH model, the ecotrophic efficiency (EE) parameter indicates the fraction of production that is:
(A) Lost to respiration
(B) Excreted as waste
(C) Assimilated into offspring
(D) Consumed or exported from the system

2007

49. Data-limited catch-only models (e.g., Catch-MSY) primarily utilize historical catch data and priors on:
(A) Carrying capacity and intrinsic growth rate
(B) Maximum age and fecundity
(C) Natural mortality and gear selectivity
(D) Trophic level and consumption rates

2010

50. Consider the following statements about R-based tools (like TropFishR):
I. They replace traditional models entirely.
II. They require no user coding knowledge.
III. They offer transparent, reproducible workflows.
IV. They integrate ELEFAN methodologies.
V. They utilize maximum likelihood estimators.
Which of the above statements are INCORRECT?
(A) II and III
(B) I and II
(C) III and IV
(D) IV and V

2021

51. The primary biological distinction between a unit stock and a population is that a unit stock:
(A) Exists solely in aquaculture systems
(B) Is an operational management concept with homogeneous parameters
(C) Has distinct genetic markers separating it fully
(D) Represents only the mature breeding individuals

2009

52. Transboundary stocks are best managed through:
(A) Unilateral state legislation
(B) Bilateral or multilateral cooperative agreements
(C) Complete harvest moratoriums
(D) Exclusive private property rights

2012

53. Which characteristic is least likely to be found in tropical multi-species fisheries?
(A) Distinct, non-overlapping cohorts
(B) High diversity of gear types
(C) Protracted spawning seasons
(D) High species richness in catches

2022

54. Meristic characteristics in fish refer to:
(A) Continuous morphological measurements
(B) Internal organ weights
(C) Behavioral patterns during spawning
(D) Countable traits such as fin rays or scales

2016

55. Strontium isotope signatures in otoliths are particularly useful for identifying:
(A) Exact daily age
(B) Diadromous migrations
(C) Dietary preferences
(D) Maximum asymptotic length

2011

56. Allozyme electrophoresis for stock identification relies on the variation in:
(A) DNA sequencing
(B) RNA transcription rates
(C) Protein mobility in an electric field
(D) Lipid concentrations in muscle tissue

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2018

57. Standardizing CPUE is crucial because raw CPUE is often biased by:
(A) Fluctuations in natural mortality
(B) Changes in genetic structures
(C) Variations in environmental conditions
(D) Changes in gear efficiency and spatial distribution

2018

58. A length-weight exponent (b) value of 2.7 indicates that the fish exhibits:
(A) Negative allometric growth
(B) Positive allometric growth
(C) Isometric growth
(D) Exponential length growth

2006

59. The primary assumption of back-calculating length from hard parts is a proportional relationship between:
(A) Natural mortality and annulus spacing
(B) Water temperature and otolith weight
(C) Trophic level and scale circuli density
(D) Fish length and hard part radius

2025

60. Consider the following steps for length-frequency analysis using ELEFAN:
I. Restructuring the length-frequency data
II. Plotting the raw length-frequency histograms
III. Identifying the peak Rn value
IV. Fitting the VBGF curves
Which of the following is the correct sequence of steps?
(A) I, II, III, IV
(B) II, I, IV, III
(C) III, I, IV, II
(D) II, IV, I, III

2005

61. The point of inflection on a typical von Bertalanffy growth curve for weight indicates the age of:
(A) Length at zero
(B) Maximum growth rate
(C) First maturity
(D) Total cessation of growth

2023

62. Which method utilizes the slope of the descending right limb of a catch curve?
(A) Estimation of intrinsic growth rate (r)
(B) Estimation of natural mortality (M)
(C) Estimation of total mortality (Z)
(D) Estimation of fishing mortality (F)

2017

63. Taylor's empirical formula estimates natural mortality based on:
(A) Environmental temperature
(B) Gonadosomatic index
(C) Maximum age and the VBGF parameter K
(D) Predator-prey ratios

2007

64. The descending limb of a Ricker curve implies that as spawning stock biomass increases to extreme levels:
(A) Recruitment increases linearly
(B) Recruitment remains constant
(C) Total mortality approaches zero
(D) Recruitment decreases

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2019

65. Carrying capacity (K) in natural water bodies represents the:
(A) Total catch limit set by managers
(B) Maximum limit of fish biomass the environment can sustain
(C) Initial biomass before fishing begins
(D) Minimum viable population size

2022

66. Mesh size regulations are primarily implemented to:
(A) Increase the capture of juvenile fish
(B) Prevent the escape of mature individuals
(C) Shift the size of first capture to larger lengths
(D) Increase total fishing effort

2021

2013

67. The Pella-Tomlinson surplus production model is a generalized model where the shape parameter (m) determines:
(A) The exact number of fleets
(B) The economic rent threshold
(C) The natural mortality exponent
(D) The asymmetry of the production curve

2004

68. A key limitation of the presidential-Holt Y/R model is its failure to account for:
(A) The relationship between spawning stock and recruitment
(B) Natural mortality changes
(C) The age of recruitment to the fishery
(D) Growth parameters like L_∞

2004

69. In cohort analysis, the number of individuals alive at the beginning of a given age interval is calculated using:
(A) The catch of the youngest age group only
(B) The catch in that interval and the survivors in the next
(C) The total biomass of the entire stock
(D) Environmental carrying capacity

2022

70. Consider the following reference points:
I. $F_{\{\max\}}$
II. $F_{\{MSY\}}$
III. $F_{\{0.1\}}$
IV. $F_{\{crash\}}$
Which of the following represents the correct ascending order of fishing mortality?
(A) III, II, I, IV
(B) II, I, IV, III
(C) III, I, II, IV
(D) I, II, III, IV

2001

71. In the Lotka-Volterra predator-prey model, an increase in predator population typically directly causes:
(A) An exponential increase in prey
(B) A decline in the prey population
(C) A decrease in predator natural mortality
(D) An immediate increase in system carrying capacity

2011

72. ECOSIM models add which dynamic component to the static ECOPATH framework?
(A) Spatial migration tracking
(B) Genetic drift simulations
(C) Time-dynamic simulations of biomass
(D) Immediate climatic forecasting

2021

73. Spawning Potential Ratio (SPR) is defined as the proportion of:
(A) Recruits surviving to maximum age
(B) Mature males to mature females
(C) Total biomass represented by eggs
(D) Unfished spawning biomass remaining under current fishing levels

2019

74. Which of the following is a primary feature of the FiSAT II software?
(A) Length-frequency based stock assessment routines
(B) Automated genetic sequencing
(C) Ocean current mapping
(D) Satellite tracking of vessel movements

2019

75. Defining a unit stock based solely on political boundaries rather than biological boundaries often leads to:
(A) Overexploitation or localized depletion
(B) Optimal sustainable yields
(C) Perfect ecosystem balance
(D) Increased natural mortality

2001

76. Highly migratory stocks are uniquely challenging to assess because:
(A) They lack distinct hard parts for aging
(B) They are caught by multiple nations with varying data qualities
(C) They exhibit zero natural mortality
(D) They do not follow the von Bertalanffy growth curve

2004

77. Which life history trait is generally characteristic of tropical pelagic fishes compared to temperate demersal fishes?
(A) Higher K values in the VBGF
(B) Larger L_∞ values
(C) Greater longevity
(D) Lower natural mortality rates

2001

78. Truss network measurements are usually taken by mapping the distances between:
(A) Random points on the fish's skin
(B) Internal skeletal structures only
(C) Various scales along the lateral line
(D) Homologous anatomical landmarks

2002

79. Chemical stock delineation assumes that the chemical composition of calcified structures reflects:
(A) Genetic mutations strictly
(B) The physical shape of the otolith
(C) The diet of the fish exactly 24 hours prior
(D) The ambient water chemistry during deposition

2012

80. Read the given assertion and reason, then select the correct option.
Assertion (A): Microsatellite markers are highly effective for fine-scale population structure analysis.
Reason (R): Microsatellites are highly

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polymorphic and exhibit rapid mutation rates.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is false but R is true.
(D) A is true but R is false.

2023
81. Fishery-dependent data is inherently subject to which primary source of bias?
(A) Complete randomization of sampling
(B) Non-representative spatial coverage driven by fisher behavior
(C) Excessive precision in biological measurements
(D) Independence from gear selectivity

2017
82. If the relative condition factor (K_n) is significantly greater than 1, it implies the fish is:
(A) Starving and underweight
(B) Exactly at its theoretical predicted weight
(C) Heavier than the average expected for its length
(D) Experiencing extremely slow length growth

2023
83. The formation of opaque zones in otoliths is generally associated with periods of:
(A) Rapid, active growth
(B) Extreme starvation
(C) Slow growth during winter
(D) Complete cessation of feeding

2010
84. Bhattacharya's method is used within length-frequency analysis primarily to:
(A) Decompose mixed length distributions into normal cohorts
(B) Estimate absolute carrying capacity
(C) Calculate the maximum economic yield
(D) Measure the selection ogive of a net

2022
85. The mathematical assumption of the VBGF is that the rate of length growth is proportional to the:
(A) Current age of the fish
(B) Difference between asymptotic length and current length
(C) Square of the fish's weight
(D) Current natural mortality rate

2022
86. An exploitation rate (E) of 0.5 suggests that fishing mortality is:
(A) Twice the natural mortality
(B) Half the natural mortality
(C) Equal to the natural mortality
(D) Unrelated to natural mortality

2021
87. In Pauly's empirical equation, which variable exerts a negative influence on the estimation of natural mortality (M)?
(A) Mean environmental temperature
(B) Maximum theoretical weight
(C) Intrinsic growth rate
(D) Maximum theoretical length (L_∞)

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2008
88. In catch curve analysis, the ascending left limb of the curve represents individuals that are:
(A) Experiencing highest natural mortality
(B) Incompletely selected by the fishing gear
(C) Fully recruited to the fishing gear
(D) At the asymptotic length

2016
89. A Beverton-Holt stock-recruitment model is best modeled for species where:
(A) Older fish actively prey on younger fish
(B) Habitat space determines the maximum number of recruits
(C) Spawning aggregation attracts heavy predation
(D) Recruitment is totally independent of spawning stock

2017
90. Match the surplus production models in List I with their key characteristics in List II.
List I: (Model)
P. Schaefer
Q. Fox
R. Pella-Tomlinson
S. Catch-MSY
List II: (Characteristic)
1. Asymmetric production curve
2. Symmetrical parabolic curve
3. Data-limited historical catch tool
4. Exponential decline in CPUE
(A) P-2, Q-4, R-1, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-3, R-1, S-4

2008

91. A sharp increase in density-independent mortality is most likely caused by:
(A) Increased competition for food
(B) An acute environmental hypoxia event
(C) Increased incidence of density-dependent diseases
(D) Overcrowding in spawning grounds

2017

92. The selection ogive for a longline hook primarily depends on the relationship between:
(A) Fish girth and mesh size
(B) Fish mouth size and hook size
(C) Fish swimming speed and vessel speed
(D) Fish vision and net color

2014

93. When fitting a surplus production model using equilibrium assumptions, a common error in developing fisheries is:
(A) Assuming catch equals equilibrium yield during expansion
(B) Underestimating Maximum Sustainable Yield
(C) Overestimating the optimum effort level
(D) Assuming a completely asymmetric growth curve

2009

94. The Thompson and Bell model is highly advantageous for management because it easily incorporates:
(A) Density-dependent natural mortality fluctuations
(B) Exact counts of microscopic larvae
(C) Changes in economic value and mesh size regulations
(D) Genetic drift in completely isolated stocks

2018

95. The primary mathematical vulnerability of Virtual Population Analysis (VPA) is its sensitivity to the assumed value of:
(A) Terminal fishing mortality
(B) Initial age of recruitment
(C) Economic discount rate
(D) Ecosystem carrying capacity

2018

96. Optimum Yield (OY) differs from MSY because OY explicitly incorporates:
(A) Only ecological constraints
(B) Economic, social, and ecological factors
(C) Purely theoretical biological limits
(D) Zero fishing effort limits

2012

97. Target Reference Points (TRPs) are designed to provide managers with:
(A) A state intended to be avoided at all costs
(B) A safe operational biological and economic target
(C) The theoretical absolute maximum limit of fishing
(D) An index of natural predation

2014

98. In Multispecies VPA (MSVPA), the stomach content data is primarily utilized to estimate:
(A) The von Bertalanffy K parameter
(B) Suitability coefficients and predation mortality
(C) The maximum depth preference of the stock
(D) Terminal fishing mortality values

2005

99. The "vulnerability" parameter in ECOSIM primarily regulates:
(A) Top-down versus bottom-up control between predator and prey
(B) The rate of natural decay of detritus
(C) The catchability coefficient of the fishing gear
(D) The accuracy of the stomach content analysis

2008

100. Consider the following statements about Length-Based Spawning Potential Ratio (LB-SPR):
I. It requires only size composition data.
II. It assumes a steady state.
III. It requires absolute abundance estimates.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2001

101. The TropFishR package in R improves upon traditional ELEFAN by:
(A) Using genetic optimization algorithms to fit growth curves
(B) Calculating MSY directly without effort data
(C) Eliminating the need for length-frequency data
(D) Providing precise daily age estimates automatically

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2014
102. Identifying a mixed stock fishery is crucial because treating it as a single unit stock often leads to:
(A) Overharvesting of the least productive species
(B) Increased overall ecosystem productivity
(C) Decreased fishing effort by the fleet
(D) Artificial genetic homogenization

2017
103. Which stock assessment approach relies entirely on historical catch time series and estimated resilience?
(A) MSVPA
(B) Thompson and Bell
(C) Catch-MSY
(D) Yield per Recruit

2017
104. Continuous spawning in tropical fisheries complicates length-frequency analysis because:
(A) Fish simply stop growing after maturity
(B) Natural mortality eliminates younger ages instantly
(C) Cohorts overlap heavily, blurring distinct modal progressions
(D) Fish do not follow asymptotic growth patterns

2009
105. A disadvantage of using truss network analysis over traditional morphometrics is:
(A) It requires highly advanced DNA sequencing
(B) It captures a poor representation of body depth
(C) It measures only internal bone structures
(D) It necessitates precise landmark placement and specialized image software

2004
106. In otolith microchemistry, a sudden spike in barium and strontium ratios often indicates:
(A) Migration between freshwater and marine environments
(B) The onset of sexual maturity
(C) A period of prolonged starvation
(D) The immediate point of capture

2022
107. Which genetic marker is characterized as codominant, highly polymorphic, and biparentally inherited?
(A) Allozymes
(B) Mitochondrial DNA
(C) Microsatellites
(D) Chloroplast DNA

2014
108. Which method represents a fishery-independent approach to estimating CPUE?
(A) Port sampling of commercial catches
(B) Logbook analysis from longline vessels
(C) Scientific research trawl surveys
(D) Observer data on commercial discards

2008
109. If a fish grows isometrically, its specific gravity and shape are assumed to:
(A) Remain perfectly constant throughout growth
(B) Change drastically with age
(C) Become increasingly elongated
(D) Fluctuate with seasonal temperature changes

2008
110. Consider the following growth estimation methodologies:
I. Otolith annuli: Accurate for temperate species.
II. Scale reading: Prone to under-aging older fish.
III. Length-frequency: Best for highly overlapping cohorts.
IV. Tag-recapture: Direct observation of individual growth.
Which of the above statement(s) is/are INCORRECT?
(A) I, II and IV
(B) I, III and IV
(C) II and III
(D) III only

2017
111. The term L_∞ in the von Bertalanffy equation represents the length at which:
(A) The growth rate theoretically equals zero
(B) The fish reaches sexual maturity
(C) The fish first enters the fishery
(D) The natural mortality is minimized

NODIA

2001
112. The instantaneous rate of total mortality (Z) relates to survival rate (S) mathematically by the equation:
(A) $S = 1 - Z$
(B) $S = Z^e$
(C) $S = e^{\{-Z\}}$
(D) $S = \ln(Z)$

2011

113. High natural mortality (M) in a stock generally correlates biologically with:
(A) Low K and high L_∞
(B) Extreme longevity and late maturity
(C) Low fecundity and high parental care
(D) High K and low L_∞

2024

114. Catch curve analysis assumes that recruitment to the fishery is:
(A) Zero in the older age classes
(B) Exponentially increasing every year
(C) Constant across the years represented in the descending limb
(D) Completely dependent on temperature

2017

115. A highly overcompensatory stock-recruitment relationship implies that at very high spawning stock sizes:
(A) Recruitment approaches an asymptote
(B) Total recruitment significantly decreases
(C) Recruitment increases exponentially
(D) Environmental factors become completely irrelevant

2013

116. The concept of carrying capacity in fisheries is fundamentally tied to:
(A) Density-independent regulation
(B) The physical volume of the fishing vessels
(C) Density-dependent population regulation
(D) The economic market demand for fish

2001

117. An increase in the mesh size of a trawl net is intended to move the $L_{\{50\}}$ value:
(A) Toward a larger length
(B) Toward a smaller length
(C) To zero
(D) To exactly equal L_∞

2009

118. A key failure of the equilibrium assumptions in simple surplus production models is ignoring:
(A) Time lags between changes in effort and population response
(B) The total weight of the catch
(C) The economic value of the catch
(D) Catchability limits of the fleet

2009

119. In yield-per-recruit analysis, $F_{\{}\text{max}_{\}}$ is the point where:
(A) Spawning biomass is maximized
(B) Total sustainable yield is achieved
(C) Yield per recruit reaches its absolute peak
(D) The marginal increase in yield is 10%

2015

120. Consider the following statements about Pope's Cohort Analysis:
I. It requires the natural mortality rate.
II. It assumes catch is continuous and uniform.
III. It assumes catch occurs as a discrete pulse mid-interval.
IV. It is mathematically an approximation of VPA.
V. It is perfectly accurate for very high mortality rates.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) II, IV and V
(C) I, III and IV
(D) I, III and V

2010

121. The limit reference point (LRP) signifies a state of a fishery that is:
(A) Unacceptable and warrants immediate management action
(B) Optimal for economic returns
(C) The ideal target for unassessed stocks
(D) Determined solely by fleet capacity

2004

122. In the ECOPATH mass-balance equation, $B_i \cdot \left(\frac{P}{B}\right)_i \cdot EE_i$ represents the:
(A) Total respiration of group i
(B) Total production of group i utilized within or exported from the system
(C) Total mortality of group i
(D) Total unassimilated food of group i

2023

123. Which index is commonly used as a proxy for spawning stock biomass in data-limited fisheries?
(A) Mean length of catch relative to length at maturity
(B) Total volume of fuel consumed by the fleet
(C) Water surface temperature anomalies
(D) Annual export volume of processed fish

NODIA

2017

124. FiSAT II incorporates the Powell-Wetherall plot primarily to estimate:
(A) Natural mortality (M)
(B) L_∞ and $\frac{Z}{K}$
(C) Length at first capture (L_c)
(D) Economic yield metrics

2021
125. The definition of a "transboundary stock" necessitates that the stock crosses:
(A) The thermocline boundary
(B) International Exclusive Economic Zone boundaries
(C) Between marine and freshwater environments
(D) From the continental shelf into the abyssal plain

2014
126. A characteristic life history trait of temperate groundfish compared to small pelagics is:
(A) Longer lifespan and later age at maturity
(B) Shorter lifespan and faster growth
(C) Higher natural mortality and early maturity
(D) Continuous year-round spawning

2015
127. Which method provides the most direct measurement of somatic fish growth?
(A) Otolith weight analysis
(B) Tagging and recapture analysis
(C) Scale annulus counting
(D) Length-frequency progression

2006
128. Truss network data is statistically analyzed most commonly using:
(A) Univariate regression
(B) Time-series forecasting
(C) Principal Component Analysis (PCA)
(D) Fourier transforms

2006
129. Otolith microchemistry assumes the otolith is metabolically inert, meaning:
(A) It dissolves slightly during starvation
(B) Elements deposited are not reabsorbed
(C) It constantly exchanges ions with the blood
(D) Its shape changes continuously based on swimming speed

2021
130. Consider the following hierarchical genetic markers:
I. Allozymes
II. mtDNA
III. Microsatellites
Which of the following is the correct sequence from lowest to highest mutation rate?
(A) I, II, III
(B) II, I, III
(C) III, II, I
(D) I, III, II

2011
131. Which of the following is considered a fishery-dependent data source?
(A) Scientific acoustic surveys
(B) Fish market landing statistics
(C) Trawl surveys by research vessels
(D) Unmanned underwater vehicle counts

2008
132. The length-weight parameter 'a' is highly variable and primarily acts as a:
(A) Measure of environmental temperature
(B) Condition factor representing fish plumpness
(C) Predictor of absolute maximum age
(D) Universal constant across all species

2010
133. Daily growth increments on otoliths are particularly useful for estimating the age of:
(A) Larval and juvenile fishes
(B) Long-lived benthic sharks
(C) Adult temperate cod
(D) Highly migratory adult tunas

2001
134. Which mathematical property defines the von Bertalanffy Growth Function (VBGF)?
(A) Growth rate in length decreases linearly as length approaches L_∞
(B) Growth in length is exponential throughout life
(C) Growth in weight is linear throughout life
(D) Growth ceases entirely upon reaching sexual maturity

2016
135. Total mortality (Z) is best described biologically as the:
(A) Instantaneous rate at which individuals are removed from the population
(B) Total number of fish dying in one day
(C) Ratio of natural to fishing deaths
(D) Maximum fraction of the population that can be harvested

2025
136. Empirical equations for natural mortality (M) are necessary primarily because:
(A) M is difficult to estimate directly from standard fishery data
(B) M is easy to measure directly but time-consuming
(C) M is extremely high in all commercially fished stocks
(D) M is a constant value of 0.2 for all fish

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2018
137. A linearized catch curve plots $\ln(N_t)$ against time (t). The slope of the descending limb equals:
(A) $-Z$
(B) F
(C) M
(D) Z

2021
138. The presidential-Holt stock-recruitment model predicts that recruitment:
(A) Approaches an asymptotic limit as stock size increases
(B) Increases indefinitely with stock size
(C) Peaks at intermediate stock sizes then declines
(D) Is completely independent of spawning stock size

2002
139. Density-dependent natural mortality typically affects a population most strongly during:
(A) Early larval and juvenile stages
(B) Peak spawning periods
(C) The absolute maximum age
(D) Periods of zero fishing effort

2013
140. Consider the following steps of conducting a Virtual Population Analysis (VPA):
I. Estimate initial terminal fishing mortality
II. Calculate survivors backward using Pope's or exact VPA equations
III. Compile catch-at-age matrix
IV. Calibrate terminal F using tuning indices
Which of the following is the correct sequence of steps?
(A) III, I, II, IV
(B) I, III, II, IV
(C) III, II, I, IV
(D) IV, III, I, II

2004
141. The length at 50% capture ($L_{\{50\}}$) is a direct measure of:
(A) Maximum asymptotic length
(B) Gear selectivity
(C) Natural mortality threshold
(D) Growth overfishing limit

2008
142. If the effort at MSY ($E_{\{MSY\}}$) is exceeded continuously, the fishery will typically experience:
(A) Biological overfishing and declining yields
(B) Economic hyper-profitability
(C) Increased surplus production
(D) An increase in carrying capacity

2024
143. Yield-per-recruit models assume that recruitment is:
(A) Constant and independent of spawning stock biomass
(B) Strongly density-dependent
(C) Linearly correlated with environmental temperature
(D) Declining exponentially with time

2007
144. In a VPA, the term "terminal F" refers to the fishing mortality rate:
(A) Which exactly equals natural mortality
(B) Of the youngest age class in the first year
(C) In the oldest age class or the most recent year
(D) At which the stock completely collapses

2024
145. MEY (Maximum Economic Yield) is fundamentally defined as the point where:
(A) Total revenue is maximized
(B) Marginal revenue is zero
(C) Marginal cost is absolutely minimized
(D) Total revenue exceeds total cost by the largest margin

NODIA

2021
146. A Biological Reference Point based on $F_{\{0.1\}}$ is generally considered to be:
(A) A conservative target reference point
(B) A highly risky target reference point
(C) An extreme limit reference point
(D) Unrelated to yield-per-recruit

2017
147. Multispecies models reveal that forage fish are often impacted by apex predators. Decreasing fishing pressure on an apex predator leads to:
(A) Increased predation mortality on forage fish
(B) Exponential increases in all lower trophic levels
(C) Decreased natural mortality on forage fish
(D) Immediate collapse of the predator

2022
148. In ECOPATH, if the Ecotrophic Efficiency (EE) of a group is greater than 1.0, the model is:
(A) Perfectly balanced
(B) Exhibiting high surplus production
(C) Indicating a pristine, unfished state
(D) Thermodynamically impossible and unbalanced

2013

149. Which fishery indicator is most commonly used to detect "serial depletion" in multi-species complexes?
(A) Expanding spatial range of the fleet
(B) Sequential collapse of high-value species followed by lower-value species
(C) Increasing mean length of the total catch
(D) Decreasing fuel efficiency of the vessels

2017

150. Read the given assertion and reason, then select the correct option.
Assertion (A): FiSAT II utilizes the ELEFAN routine primarily to extract age composition directly from scales.
Reason (R): ELEFAN fits a von Bertalanffy growth curve to length-frequency peaks without requiring physical hard parts.
(A) Both A and R are true and R is the correct explanation of A.
(B) A is true but R is false.
(C) A is false but R is true.
(D) Both A and R are true but R is not the correct explanation of A.

2022

151. A fishery exploiting a highly migratory stock requires management primarily through:
(A) Regional Fisheries Management Organizations (RFMOs)
(B) Local municipal ordinances
(C) Unilateral tariffs on fish products
(D) Subsidizing localized artisanal fleets

2010

152. Which biological trait makes tropical stocks generally more resilient to high fishing pressure than temperate stocks?
(A) Earlier age at maturity and rapid turnover
(B) Lower fecundity
(C) Slower intrinsic growth rates
(D) Extremely long lifespans

2011

153. A "mixed stock" in fisheries assessment typically implies:
(A) A catch of multiple populations managed as one unit
(B) A single species managed under multiple conflicting legal frameworks
(C) A population exhibiting completely uniform and stable age structures
(D) A stock composed solely of mature intersex individuals in the wild

2007

154. The process of truss network analysis typically begins with:
(A) Photographing the specimen and digitizing homologous landmarks
(B) Sequencing the mitochondrial genome
(C) Weighing the fish to the nearest milligram
(D) Extracting the sagittal otolith

2006

155. What chemical signature in otoliths helps reconstruct past temperatures?
(A) The ratio of Oxygen-18 to Oxygen-16
(B) The ratio of Carbon-14 to Carbon-12
(C) The absolute concentration of lead
(D) The radioactive decay of uranium

2014

156. Genetic stock identification is most fundamentally based on the concept that isolated stocks will exhibit:
(A) Identical allele frequencies
(B) Zero genetic mutations
(C) Divergent allele frequencies due to drift and selection
(D) Perfect phenotypic identicality

2015

157. Which variable is most frequently used to standardize CPUE using Generalized Linear Models (GLMs)?
(A) Vessel horsepower or gear size
(B) Fish scale color
(C) Phytoplankton density precisely at capture
(D) The specific day of the week

2016

158. If a fish's length-weight exponent is $b = 3.2$, its physical form during growth:
(A) Becomes relatively thinner
(B) Becomes relatively plumper or deeper
(C) Remains exactly proportional
(D) Changes from bilaterally symmetrical to asymmetrical

2018

159. Annual growth rings in scales are primarily formed due to:
(A) Seasonal variations in growth rates
(B) Constant year-round growth
(C) Lunar tidal cycles
(D) Daily migrations through the thermocline

2016

160. Match the software/tools in List I with their primary analytical function in List II.
List I: (Software/Tool)

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P. FiSAT II
Q. ECOPATH
R. TropFishR
S. Catch-MSY

List II: (Function)

1. Data-limited MSY estimation
2. Length-frequency based stock assessment
3. Mass-balance ecosystem modeling
4. Modern R-package for length-based analysis

(A) P-2, Q-3, R-4, S-1
(B) P-3, Q-1, R-2, S-4
(C) P-1, Q-4, R-3, S-2
(D) P-2, Q-4, R-1, S-3

2005

161. An assumption of the von Bertalanffy growth equation is that anabolism scales with:
(A) Surface area, and catabolism with weight (volume)
(B) Volume, and catabolism with length
(C) Length, and catabolism with surface area
(D) Weight, and catabolism with surface area

2016

162. The natural mortality rate (M) is considered mathematically as an:
(A) Instantaneous rate of death
(B) Absolute number of dead fish
(C) Average percentage dying per decade
(D) Additive constant solely related to fishing

2015

163. Which empirical equation relies exclusively on maximum age ($t_{\{\max\}}$) to estimate natural mortality?
(A) Hoenig's formula
(B) Pauly's formula
(C) Taylor's formula
(D) Beverton's formula

2006

164. The primary difficulty in determining stock-recruitment relationships empirically is:
(A) High environmentally-driven stochasticity in survival of early life stages
(B) Recruitment varies minimally year to year
(C) The parameters are fully deterministic
(D) Fishing mortality prevents any recruitment

2005

165. Density-independent mortality factors include:
(A) Salinity shock from sudden freshwater influx
(B) Intraspecific competition for breeding sites
(C) Predation by specialized natural predators
(D) Disease transmission in dense schools

2009

166. A trawl net selection curve is often asymmetrical, heavily skewed to the right, due to:
(A) Smaller fish being trapped in the codend by larger fish
(B) Larger fish escaping through broken meshes
(C) The exact shape of the otter boards
(D) The color of the netting material

2003

167. The Schaefer model produces a symmetric parabola for yield versus effort, which implies MSY occurs at exactly:
(A) 50% of carrying capacity
(B) 25% of carrying capacity
(C) 75% of carrying capacity
(D) 100% of carrying capacity

2022

168. The Thompson and Bell model outputs are heavily dependent on knowing the:
(A) Age- or size-specific fishing mortality and weights
(B) Natural mortality of competing species
(C) Exact carrying capacity of the ecosystem
(D) Maximum asymptotic age geometrically

2002

169. Pope's cohort analysis introduces a negligible error compared to strict VPA when total mortality (Z) is:
(A) Less than 1.2 and catch is concentrated mid-year
(B) Extremely high (e.g., $Z > 2.0$)
(C) Completely zero
(D) Exponentially increasing each month

NODIA

2002

170. Consider the following parameters for determining the Optimum Yield (OY):
I. Biological yield limits (MSY)
II. Economic profitability
III. Social or ecological objectives
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2001

171. A limit reference point (LRP) for spawning stock biomass is typically defined as a point where:
(A) Recruitment is severely compromised (recruitment overfishing)
(B) Maximum revenue is generated
(C) The stock first enters the fishery

(D) Natural mortality is zero

2006

172. Multispecies VPA (MSVPA) primarily requires extensive data on:
(A) Predator stomach contents
(B) Surface sea temperatures
(C) Fishing vessel fuel consumption
(D) Market price fluctuations

2004

173. The primary assumption of a mass-balance model like ECOPATH is that over the modeled time period:
(A) The system is in steady state
(B) Biomass increases exponentially
(C) All species migrate out of the system
(D) Fishing mortality is constant at zero

2022

174. Length-Based Spawning Potential Ratio (LB-SPR) estimates SPR directly from:
(A) Size composition of the catch and life-history ratios ($\frac{M}{K}$, L_m)
(B) Catch per unit effort logs
(C) Acoustic survey biomass
(D) Daily growth increments on otoliths

2013

175. Which feature is unique to the TropFishR package compared to the legacy FiSAT II software?
(A) It incorporates advanced bootstrapped confidence intervals for growth parameters
(B) It runs exclusively on a graphical user interface with no code
(C) It cannot perform length-frequency analysis
(D) It only analyzes temperate species

2012

176. Which type of stock requires assessment models that account for fish moving outside a nation's EEZ into international waters?
(A) Straddling stock
(B) Transboundary stock
(C) Unit stock
(D) Endemic stock

2005

177. The most critical biological challenge in assessing tropical multispecies fisheries is:
(A) The lack of discrete age classes due to continuous spawning
(B) Unavailability of any biological data
(C) The complete absence of predation
(D) The extremely slow growth of all species

2006

178. Meristic characters are advantageous in field studies because they:
(A) Are fixed early in development and remain constant
(B) Change rapidly with short-term diet changes
(C) Are highly influenced by specimen preservation methods
(D) Measure absolute continuous length accurately

2007

179. Otolith microchemistry profiling across a transect from the core to the edge reveals:
(A) The ontogenetic life history and environmental migrations
(B) The genetic mutations accrued over a lifetime
(C) The exact weight of the fish at every age
(D) The sex of the fish

2007

180. Consider the following genetic markers:
I. Allozymes: Direct DNA sequencing
II. mtDNA: Maternal inheritance
III. Microsatellites: High mutation rate
IV. SNPs: Single base-pair variations
Which of the above combination(s) is/are INCORRECT?
(A) I only
(B) II and III
(C) I and IV
(D) III only

2025

181. Fishery-dependent CPUE data can mask stock collapse due to:
(A) Hyperstability, where fleets target dense aggregations
(B) Random stratified sampling design
(C) The complete absence of fishing effort
(D) Use of exact acoustic biomass estimates

2015

182. A condition factor (K) value decreasing rapidly over a few months most likely indicates:
(A) Post-spawning weight loss or severe starvation
(B) Rapid weight gain
(C) Improved feeding conditions
(D) Transition to positive allometric growth

2018

183. Validation of age estimates from hard parts is most rigorously achieved by:
(A) Mark-recapture with chemical tagging (e.g.,

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oxytetracycline)
(B) Assuming one ring equals one year
(C) Measuring the total length of the fish
(D) Counting rings on multiple scales from the same fish

2002
184. The Bhattacharya method relies on plotting length-frequency data using:
(A) Logarithmic differences of frequencies to identify normal distributions
(B) Estimate absolute carrying capacity
(C) Temperature gradients against depth
(D) Acoustic backscatter strength

2017
185. In the VBGF, if t_0 is negative, it implies that at age zero the theoretical length is:
(A) Positive
(B) Zero
(C) Negative
(D) Equal to L_∞

2019
186. The instantaneous rate of fishing mortality (F) is directly proportional to:
(A) Catchability (q) and Fishing Effort (f)
(B) Natural mortality (M)
(C) Maximum age
(D) Carrying capacity

2013
187. Pauly's empirical formula for M incorporates mean environmental temperature because:
(A) Higher temperatures generally increase metabolic and mortality rates
(B) Temperature directly dictates exact genetic mutations
(C) Cold water fish always die younger
(D) Temperature affects the catchability of trawls

2005
188. In catch curve analysis, excluding the oldest, scarcely represented age classes is necessary to avoid:
(A) Violating the assumption of constant mortality due to small sample bias
(B) Underestimating natural mortality
(C) Overestimating juvenile abundance
(D) Calculating an infinite carrying capacity

2002
189. A key mechanism producing a presidential-Holt stock-recruitment curve is:
(A) Territoriality and a fixed number of safe refuge sites
(B) Cannibalism by adults on juveniles
(C) Allee effects at exceptionally low densities
(D) Complete absence of density-dependent regulation

2014
190. Consider the following statements about carrying capacity (K) in population dynamics:
I. It is the maximum population size sustainable by the environment.
II. It is the point where population growth rate is zero.
III. It fluctuates with environmental changes.
IV. It is strictly determined by fishing effort.
V. It equals the MSY point.
Which of the above statement(s) is/are correct?
(A) I, II and III
(B) II, III and V
(C) I, II and III
(D) III, IV and V

2005
191. The probability of capture curve for a gillnet is typically:
(A) A logistic ogive
(B) Bell-shaped (normal distribution)
(C) Exponentially increasing
(D) A perfectly straight line

2007
192. The Fox surplus production model suggests that as effort increases indefinitely, yield approaches:
(A) Zero asymptotically
(B) Negative values
(C) Infinity
(D) A constant maximum sustainable value

NODIA

2005
193. The primary output of a presidential-Holt Yield-per-Recruit model is a graphical contour plot showing $\frac{Y}{R}$ as a function of:
(A) Fishing mortality and age at first capture
(B) Natural mortality and carrying capacity
(C) Environmental temperature and salinity
(D) Total biomass and recruitment

2021
194. A fundamental difference between VPA and surplus production models is that VPA:
(A) Reconstructs historical population numbers by distinct age cohorts
(B) Treats the entire population as a single unaged biomass pool
(C) Completely ignores natural mortality
(D) Requires no catch data

2017
195. Operating a fishery strictly at MSY is biologically risky because:
(A) It ignores environmental variability and potential recruitment failure
(B) Economic profits are always negative at MSY
(C) It leads to massive under-utilization of the resource
(D) It naturally reduces the catchability coefficient

2022
196. The limit reference point $F_{\{crash\}}$ indicates the fishing mortality rate at which:
(A) The population is driven to theoretical extinction
(B) Spawning biomass yields maximum economic return
(C) Yield is 10% of maximum
(D) Recruitment is at its absolute maximum

2009
197. Incorporating predation explicitly into stock assessment via MSVPA generally results in:
(A) Higher estimated natural mortality for younger age classes
(B) Constant natural mortality for all ages
(C) Lower estimated natural mortality for forage fish
(D) Elimination of fishing mortality calculations

2019
198. In ECOSIM, the basic equation solving for biomass changes over time utilizes:
(A) Differential equations integrating growth, mortality, and consumption
(B) Simple linear regression against time
(C) The exact von Bertalanffy curve for the entire ecosystem
(D) Acoustic backscatter integrations exclusively

2001
199. A primary advantage of the LB-SPR methodology is that it provides a robust assessment of stock status without needing:
(A) Total catch volumes or absolute effort data
(B) Any knowledge of life history
(C) Length frequency distributions
(D) Parameters M and K

2024
200. Read the given assertion and reason, then select the correct option.
Assertion (A): The ELEFAN method is highly sensitive to the proper identification of distinct peaks in length-frequency data.
Reason (R): ELEFAN utilizes a goodness-of-fit metric (R_n) to maximize the alignment of the VBGF curve with these structural peaks.
(A) A is true but R is false.
(B) Both A and R are true but R is not the correct explanation of A.
(C) Both A and R are true and R is the correct explanation of A.
(D) A is false but R is true.

2004
201. Which classification best describes a stock entirely confined within the EEZ of a single nation?
(A) Domestic or national stock
(B) Straddling stock
(C) Transboundary stock
(D) Unit stock

2019
202. The concept of a "unit stock" relies fundamentally on the assumption of:
(A) Complete reproductive isolation and homogeneous population parameters
(B) Constant migration between adjacent oceans
(C) Extremely high genetic diversity within the single cohort
(D) Zero fishing pressure

2016
203. Tropical fish typically exhibit which type of growth pattern compared to temperate species?
(A) Higher K, lower L_∞
(B) Lower K, higher L_∞
(C) Equal K, equal L_∞
(D) Zero K, infinite L_∞

2024
204. Morphometric characteristics are generally distinguished from meristic characters because morphometrics are:
(A) Continuous measurements of body parts
(B) Strictly qualitative
(C) Expressed as exact integer counts
(D) Identical regardless of preservation method

2005
205. Otolith microchemistry is most compromised by:
(A) Contamination during handling and sample preparation
(B) Careful laboratory extraction
(C) Immediate freezing of the specimen
(D) Using highly advanced mass spectrometry

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2018
206. Which genetic technique is best suited for identifying recent hybridization between distinct fish stocks?
(A) Nuclear microsatellite analysis
(B) Traditional morphometrics
(C) Mitochondrial DNA sequencing
(D) Scale annuli reading

2004
207. A fishery-dependent index of abundance is most robust when the fleet:
(A) Randomly distributes its effort across the entire species range
(B) Targets specific spawning aggregations exclusively
(C) Upgrades its sonar equipment annually without documentation
(D) Consistently discards small fish at sea

2013
208. When fitting the length-weight relationship $W = aL^b$, the data is typically linearized using:
(A) Logarithmic transformation
(B) Sine transformation
(C) Exponential squaring
(D) Inverse proportions

2011
209. The presence of false annuli on scales can lead to:
(A) Overestimation of age
(B) Overestimation of growth rate (K)
(C) Underestimation of age
(D) Exact determination of daily age

2002
210. Match the growth/mortality parameters in List I with their standard symbols in List II.
List I: (Parameter)
P. Asymptotic length
Q. Natural mortality
R. Exploitation rate
S. Curvature parameter
List II: (Symbol)
1. M
2. L_∞
3. K
4. E
(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

2004
211. The formula $Z = F + M$ strictly implies that fishing and natural mortality operate as:
(A) Competing, simultaneous continuous exponential rates
(B) Sequential processes exclusively
(C) Mutually exclusive events
(D) Additive constants independent of population size

2002
212. In Hoenig's equation, a higher maximum observed age ($t_{\{\max\}}$) predicts:
(A) A lower natural mortality (M)
(B) A higher natural mortality (M)
(C) A completely constant M across species
(D) Zero fishing mortality

2005
213. The x-axis of a standard linearized catch curve represents:
(A) Time or relative age
(B) The natural log of catch
(C) Total biomass
(D) The specific fishing gear used

2017
214. Density-dependent effects in fish populations generally act as a:
(A) Stabilizing force preventing unlimited population growth
(B) Destabilizing force promoting extinction
(C) Random environmental noise
(D) Purely theoretical concept with no field evidence

2005
215. A Ricker stock-recruitment curve is characterized by a recruitment level that:
(A) Increases to a peak then declines at high stock densities
(B) Always strictly equals the spawning biomass
(C) Approaches an asymptote and remains flat
(D) Is continuously linear

2016
216. Which parameter directly measures the steepness or sharpness of a trawl selection ogive?
(A) The selection range (e.g., $L_{\{75\}} - L_{\{25\}}$)
(B) The maximum asymptotic length (L_∞)
(C) The absolute catch per unit effort
(D) The natural mortality exponent

2012
217. The basic equation for equilibrium yield in the Schaefer model is:
(A) $Y = aE + bE^2$

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(B) $Y = a \cdot e^{bE}$

(C) $Y = a + \frac{b}{E}$

(D) $Y = \ln(E)$

2021

218. Yield-per-recruit curves often lack a distinct peak ($F_{\{\max\}}$) in species that have:
(A) Very high natural mortality relative to growth rate
(B) Extremely slow growth rates
(C) Very low natural mortality and fast growth
(D) Instantaneous recruitment

2001

219. Virtual Population Analysis (VPA) is fundamentally a:
(A) Backward-calculating deterministic accounting model of past population states
(B) Forward-projecting predictive tool for future climate states
(C) Simple linear regression of catch and effort
(D) Real-time acoustic biomass estimation technique

2019

220. Read the given assertion and reason, then select the correct option.
Assertion (A): The Maximum Economic Yield (MEY) is always achieved at a lower level of fishing effort than the Maximum Sustainable Yield (MSY).
Reason (R): As fishing effort increases toward MSY, the marginal cost of fishing eventually exceeds the marginal revenue before MSY is reached.
(A) A is false but R is true.
(B) Both A and R are true and R is not the correct explanation of A.
(C) Both A and R are true and R is the correct explanation of A.
(D) A is true but R is false.

2023

221. Biological reference points calculated from Yield-per-Recruit analysis (e.g., $F_{\{\max\}}$) explicitly ignore:
(A) The relationship between spawning stock size and subsequent recruitment
(B) The mathematical growth of the individual fish
(C) The specific age at which fish are caught
(D) The natural mortality rate

2013

222. The Lotka-Volterra equations represent population changes of predators and prey as a function of:
(A) The interaction frequency and conversion efficiencies between the two species
(B) Absolute temperature variations
(C) External fishing pressure only
(D) Complete spatial isolation of the two groups

2003

223. In an ECOPATH model, diet composition data is inputted primarily as:
(A) Proportions (percentages) of prey groups in the diet of predators
(B) Exact weights of all consumed items in grams
(C) Total annual caloric intake of the ecosystem
(D) Length measurements of the stomach

2004

224. Catch-only models (like Catch-MSY) attempt to estimate population parameters using an assumed mathematical prior for the stock's:
(A) Intrinsic rate of population increase (r)
(B) Precise daily age
(C) Scale annuli counts
(D) Complete mitochondrial genome

2014

225. The Powell-Wetherall plot is specifically used to estimate L_∞ and $\frac{Z}{K}$ using data derived exclusively from:
(A) Length-frequency distributions
(B) Absolute total catch weights
(C) Mark-recapture experiments
(D) Stomach content volumes

2025

226. A unit stock defined for management purposes may contain:
(A) Slight genetic variations, provided population dynamics parameters are homogeneous
(B) Fish from completely unrelated marine and freshwater taxa
(C) Only perfectly identical clones
(D) Species that never interact ecologically

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2007

227. Management of highly migratory species like tuna is inherently difficult due to:
(A) The necessity of multi-national compliance and shared data
(B) Their lack of commercial value
(C) Their extremely slow swimming speeds
(D) Their strictly benthic lifecycle

2024
228. Assessing tropical multi-species fisheries using standard analytical models is complicated because:
(A) Identifying individual species in catch records is often difficult or aggregated
(B) Catchability changes dramatically with single species targets
(C) Natural mortality is universally zero
(D) Tropical fish lack calcified structures entirely

2001
229. Truss networks are mathematically advantageous over traditional morphometrics because they:
(A) Ensure uniform coverage of the body shape in two dimensions
(B) Only require the measurement of a single anatomical length
(C) Are immune to the effects of genetic drift
(D) Completely replace the need for genetic testing

2012
230. Match the ecological/stock modeling approach in List I with its core mathematical basis in List II.
List I: (Model)
P. VPA
Q. Schaefer Model
R. ECOPATH
S. Y/R Model
List II: (Mathematical Basis)
1. Logistic population growth equation
2. Mass-balance linear equations
3. Cohort survival equation
4. Continuous growth and mortality integrals
(A) P-2, Q-4, R-1, S-3
(B) P-3, Q-1, R-2, S-4
(C) P-1, Q-3, R-4, S-2
(D) P-3, Q-4, R-2, S-1

2007
231. Identifying mixed stocks using allozyme electrophoresis relies on detecting:
(A) Divergent frequencies of distinct protein variants
(B) Fixed shape differences in the otoliths
(C) Total lipid content of the liver
(D) Variations in absolute fish length

2013
232. Nominal CPUE differs from standardized CPUE primarily because nominal CPUE:
(A) Is the raw unadjusted ratio of catch to effort
(B) Accounts for all environmental and gear variations
(C) Is purely theoretical
(D) Incorporates economic value directly

2001
233. A condition factor (K) calculated for a specific fish stock frequently varies with:
(A) Season, sexual maturity, and food availability
(B) Absolute longitude lines
(C) The exact make of the fishing vessel
(D) The language spoken by the fishers

2018
234. Otolith annuli reading in tropical species is often challenging because:
(A) Minimal seasonal temperature variations prevent clear opaque/translucent zone formation
(B) The otoliths dissolve immediately upon death
(C) Tropical fish do not possess sagittal otoliths
(D) Tropical fish live for extremely long periods

2016
235. The slope of a von Bertalanffy growth curve at the point of origin ($t = 0$) is biologically meaningless if t_0 is mathematically fitted below zero because:
(A) Fish cannot have negative age
(B) Fish grow fastest exactly at zero length
(C) The length-weight exponent is perfectly 3
(D) Natural mortality is infinite

2023
236. The mathematical relationship $E = \frac{F}{Z}$ denotes that the exploitation rate is the fraction of:
(A) Total deaths in the population caused by fishing
(B) Total catch that is economically viable
(C) The population that is naturally predated
(D) The carrying capacity currently occupied

2010
237. Which method directly estimates the natural mortality (M) by plotting total mortality (Z) against fishing effort (f) over several years?
(A) The regression intercept method
(B) Pope's cohort method
(C) Pauly's formula
(D) Length-based SPR

2011
238. Catch curve analysis assumes that the catch accurately reflects the:
(A) True age structure of the population above the age of full selection
(B) Total biomass of the entire ocean

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2024
261. The growth parameter K in the VBGF essentially describes:
(A) How quickly the fish approaches its maximum size
(B) The absolute maximum length
(C) The stress level of the fish
(D) The precise age of death

2009
262. If natural mortality (M) is 0.2 and fishing mortality (F) is 0.6, the exploitation rate (E) is:
(A) 0.75
(B) 0.80
(C) 0.33
(D) 0.40

2002
263. Pauly's empirical equation for M is fundamentally based on a multiple regression of M against:
(A) L_∞, K, and temperature
(B) Z, F, and catch
(C) Mesh size and vessel length
(D) Maximum age only

2012
264. In a linearized catch curve, a non-linear convex ascending limb implies that those younger age classes are:
(A) Incompletely recruited to the fishing gear
(B) Highly targeted by the fishery
(C) Experiencing zero natural mortality
(D) Growing at an infinite rate

2013
265. The term "recruitment overfishing" strictly refers to a state where:
(A) The spawning stock is depleted to a level that severely impairs subsequent recruitment
(B) Fish are caught before they reach their optimal growth size
(C) Economic returns are minimized
(D) The fishery catches primarily post-spawning adults

2001
266. Which type of natural mortality regulation prevents a stock from growing exponentially forever?
(A) Density-dependent regulation
(B) Density-independent regulation
(C) Climatic variation
(D) Zero-sum growth models

2012
267. Mesh size regulations attempt to prevent "growth overfishing" by ensuring fish are not caught before they:
(A) Realize their major somatic growth potential
(B) Hatch from their eggs
(C) Exceed their maximum asymptotic length
(D) Are completely digested by predators

2019
268. The Fox surplus production model assumes that population growth follows an asymmetric curve, typical for species that:
(A) Attain maximum production at biomass levels below 50% of carrying capacity
(B) Respond linearly to fishing
(C) Attain maximum production exactly at 100% of carrying capacity
(D) Show no density-dependent compensation

2015
269. The presidential-Holt $\frac{Y}{R}$ equation models a single cohort's biomass by integrating over time the competing rates of:
(A) Somatic growth and total mortality
(B) Reproduction and starvation
(C) Genetic mutation and environmental drift
(D) Economic inflation and fuel costs

2024
270. Pope's cohort analysis uses a discrete approximation that mathematically treats the catch as occurring:
(A) Instantaneously precisely in the middle of the year
(B) Continuously throughout the year
(C) Entirely on the first day of the year
(D) Only on the very last day of the year

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2001
271. Maximum Sustainable Yield (MSY) assumes the stock dynamics are at equilibrium, meaning:
(A) The harvest exactly matches the surplus production generated at that biomass level
(B) Biomass continuously increases
(C) The harvest removes the entire standing stock
(D) Natural mortality equals exactly zero

2007
272. A Target Reference Point (TRP) based on $F_{\{MSY\}}$ is increasingly viewed by modern fisheries management as:
(A) A limit reference point rather than a target due to inherent uncertainty
(B) An absolute minimum threshold for viable

steady-state (equilibrium)
(B) It provides absolute biomass estimates perfectly
(C) It requires precise daily aging of thousands of samples
(D) It works only on freshwater species

2014
250. The ELEFAN routine fits the VBGF by maximizing the R_n score, which mathematically represents the:
(A) Proportion of available structural peaks passing through the fitted growth curve
(B) Maximum absolute weight of the fish
(C) Ratio of genetic diversity to total population
(D) Economic rent generated by the fishery

2021
251. A population managed as a unit stock despite comprising multiple genetically isolated sub-populations is prone to:
(A) Localized extinction of the least productive sub-populations
(B) Maximum theoretical sustainability
(C) Rapid artificial speciation
(D) Perfect equilibrium dynamics

2004
252. The UN Fish Stocks Agreement specifically provides a framework for managing:
(A) Straddling and highly migratory fish stocks
(B) Strictly inland freshwater stocks
(C) Estuarine mangrove species alone
(D) Coral reef ornamental fish

2025
253. In tropical fisheries, continuous recruitment often results in length-frequency histograms that:
(A) Form a single, unimodal distribution lacking distinct cohort peaks
(B) Show widely separated, distinct modal peaks
(C) Exhibit perfectly linear growth lines
(D) Lack any fish above the size of maturity

2002
254. Principal Component Analysis (PCA) applied to truss network data primarily serves to:
(A) Reduce dimensionality and identify the most significant shape variations
(B) Increase the overall weight of the fish
(C) Identify the specific genes responsible for growth
(D) Calculate the maximum sustainable yield directly

2019
255. Barium (Ba) concentration in fish otoliths is often strongly correlated with:
(A) Estuarine and freshwater environments
(B) High salinity deep ocean waters
(C) The absolute depth of the water
(D) The physical age of the fish in days

2003
256. Microsatellite markers are especially useful for distinguishing closely related stocks because they are:
(A) Non-coding regions that accumulate mutations rapidly
(B) Completely genetically conserved and identical across all species
(C) Inherited strictly maternally
(D) Found exclusively in the mitochondria

2007
257. An index of abundance derived from commercial catch data is often non-linear with true abundance due to:
(A) Changes in gear efficiency and spatial targeting over time
(B) Randomization of commercial fishing effort
(C) The lack of any density-dependent effects
(D) The use of perfectly standardized scientific vessels

2019
258. A Fulton's condition factor (K) is only truly comparable across different sized fish of the same species if growth is:
(A) Isometric ($b = 3$)
(B) Highly allometric
(C) Strictly exponential
(D) Completely zero

2009
259. Reading daily rings on otoliths is generally performed using:
(A) Compound microscopes or scanning electron microscopy (SEM)
(B) Plain human eyesight
(C) Low-power magnifying glasses
(D) Simple weight scales

2008
260. The Powell-Wetherall method transforms length-frequency data to calculate L_∞ by plotting the mean length of fish completely selected against:
(A) Cut-off length (L')
(B) Total fishing effort
(C) Environmental temperature
(D) Time in years

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(C) Absolute number of larvae in the ecosystem
(D) Genetic diversity of the stock

2018
239. A fundamental assumption of the Ricker model is that the primary source of density-dependent mortality is:
(A) Cannibalism or the spread of disease proportional to initial cohort density
(B) Highly specialized external predators
(C) Competition for limited spatial refuge
(D) Independent of the initial number of spawners

2011
240. Density-independent population regulation implies that proportional mortality remains constant regardless of:
(A) The population density or size
(B) The type of fishing gear used
(C) Sudden changes in water temperature
(D) The economic market dynamics

2022
241. Changing a trawl net's mesh from diamond to square mesh typically alters the selection ogive by:
(A) Making the selection curve steeper (sharper selection)
(B) Making it significantly flatter
(C) Decreasing the length at 50% capture ($L_{\{50\}}$)
(D) Catching exclusively juvenile fish

2019
242. In the Schaefer model, if current biomass is below $B_{\{MSY\}}$, maintaining fishing effort exactly at $E_{\{MSY\}}$ will mathematically cause the biomass to:
(A) Increase toward $B_{\{MSY\}}$
(B) Decline toward zero
(C) Immediately jump to carrying capacity
(D) Remain indefinitely at the exact depleted level

2018
243. The presidential-Holt Y/R model is fundamentally sensitive to the parameter t_c, which represents the:
(A) Age at first capture
(B) Maximum age of the fish
(C) Theoretical age at length zero
(D) Time elapsed during VPA

2024
244. VPA typically suffers from "convergence error" moving backward in time, meaning that:
(A) Initial guessed terminal F errors dissipate and estimates for younger ages become highly accurate
(B) Errors in terminal F estimates are exponentially magnified in younger ages
(C) The total stock biomass collapses due to mathematical instability
(D) The model is unable to resolve scenarios with zero natural mortality

2023
245. Operating a fishery strictly at MSY is biologically risky because:
(A) It ignores environmental variability and potential recruitment failure
(B) Economic profits are always negative at MSY
(C) It leads to massive under-utilization of the resource
(D) It naturally reduces the catchability coefficient

2010
246. $F_{\{0.1\}}$ is defined mathematically as the fishing mortality rate at which the slope of the yield-per-recruit curve is:
(A) Exactly 10% of the slope at the origin
(B) Zero
(C) Exactly 100% of the slope at the origin
(D) Negative

2014
247. MSVPA differs from standard VPA principally because it replaces a constant natural mortality (M) with:
(A) A variable residual mortality (M_1) and calculated predation mortality (M_2)
(B) Completely zero natural mortality
(C) A function strictly dependent on ocean temperature
(D) Density-independent starvation mortality

NODIA

2016
248. In ECOSIM time-dynamic simulations, forcing functions are typically used to represent:
(A) External time-series drivers like fishing effort or environmental changes
(B) Constant, unvarying genetic mutation rates
(C) The exact shape of the fish otolith
(D) Market price of the target species

2013
249. Which statement is the most valid limitation of Length-Based Spawning Potential Ratio (LB-SPR)?
(A) It is highly sensitive to the assumption of a

fishing
(C) A highly conservative safe target
(D) Irrelevant for any commercial fishery

2014
273. Multispecies Virtual Population Analysis (MSVPA) iteratively solves for:
(A) Predation mortality by linking prey numbers to predator consumption demands
(B) Absolute genetic divergence times
(C) Economic profitability of varying mesh sizes
(D) Global ocean temperature increases

2018
274. In ECOPATH, the basic input parameters required for each functional group typically include Biomass, $\frac{P}{B}$ ratio, $\frac{Q}{B}$ ratio, and:
(A) Ecotrophic Efficiency (EE) or Diet Composition
(B) Exact genetic sequences
(C) Individual fish scale annuli
(D) High-resolution satellite tracks

2008
275. The Length-Based Spawning Potential Ratio (LB-SPR) model mathematically requires an assumption regarding the ratio of:
(A) $\frac{M}{K}$
(B) $\frac{L_\infty}{W_\infty}$
(C) $\frac{F}{M}$
(D) Biomass / Catch

2009
276. Which algorithm is recognized as the foundational method for length-frequency analysis in data-poor tropical fisheries?
(A) ELEFAN
(B) VPA
(C) Thompson and Bell
(D) ECOSIM

2011
277. The term "metapopulation" in fisheries science refers to:
(A) A network of spatially separated populations interacting via larval dispersal or migration
(B) A single perfectly homogeneous population
(C) A population entirely enclosed within a lake
(D) A theoretical population with zero mortality

2002
278. Straddling fish stocks are most commonly found traversing the boundary between:
(A) An Exclusive Economic Zone (EEZ) and the high seas
(B) Two adjacent rivers
(C) Estuaries and freshwater lakes
(D) The epipelagic and mesopelagic zones

2002
279. The high species diversity and low absolute abundance of individual species in tropical fisheries make it difficult to:
(A) Employ standard length-frequency sampling due to inadequate sample sizes per species
(B) Find any fish in the tropics
(C) Calculate simple temperature records
(D) Use completely automated robotic fishing gears

2010
280. A major drawback of using meristic counts for stock identification is that they:
(A) Are extremely difficult to count precisely on small specimens
(B) Are continuously changing throughout a fish's entire life
(C) Cannot be used on freshwater species
(D) Have no genetic basis whatsoever

2005
281. The isotopic signature of oxygen ($\delta^{18}O$) in otoliths is primarily dependent on the water's temperature and:
(A) The isotopic composition of the ambient water
(B) The absolute depth of the water
(C) The physical age of the fish
(D) The specific diet consumed

2006
282. Mitochondrial DNA is often utilized in fisheries genetics because its high mutation rate allows for resolution of:
(A) Fine-scale, relatively recent population structuring
(B) Deep evolutionary divergences spanning billions of years
(C) Total ecosystem biomass limits
(D) Absolute age determination in long-lived species

2023
283. GLM (Generalized Linear Modeling) standardization of CPUE typically attempts to isolate the "Year" effect, which represents:
(A) The true underlying trend in stock abundance
(B) The changing skill of the specific captain
(C) The variations in moon phase

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(D) The exact size of the fishing net

2019
284. A relative condition factor (K_n) is calculated using the ratio of:
(A) Observed weight to expected theoretical weight for that length
(B) Observed length to expected theoretical length for that age
(C) Maximum age to length at maturity
(D) Catch rate to natural mortality

2010
285. In older fish, somatic growth in length slows drastically, meaning that age determination via length-frequency analysis becomes:
(A) Unreliable due to the overlapping of length modes
(B) Highly precise
(C) Entirely based on weight rather than length
(D) Independent of the VBGF parameters

2014
286. If a fish population exhibits a high K value in the von Bertalanffy equation, the species is likely:
(A) Fast-growing and short-lived
(B) Slow-growing and long-lived
(C) Exhibiting zero natural mortality
(D) Immune to growth overfishing

2013
287. The total mortality (Z) estimated from a catch curve represents the average mortality rate:
(A) Experienced by the fully recruited age classes represented in the descending limb
(B) Over the entire life of the fish starting from the egg stage
(C) Solely due to predation
(D) Solely due to commercial fishing

2004
288. Hoenig's empirical method relies on the biological premise that a stock with a high maximum observed age ($t_{\{\max\}}$) must inherently possess:
(A) Low natural mortality
(B) High fecundity
(C) High natural mortality
(D) Extreme vulnerability to fishing gear

2016
289. The ascending limb of a Ricker stock-recruitment curve is primarily driven by:
(A) Proportional increases in recruitment strictly tracking increases in spawner abundance
(B) Density-dependent cannibalism
(C) Density-independent environmental factors limiting absolute survival
(D) Saturation of available spawning habitat

2016
290. Environmental carrying capacity (K) implies that above a certain biomass threshold, population growth becomes:
(A) Zero or negative
(B) Exponential
(C) Linear
(D) Irrelevant

2023
291. A sharp selection curve for a trawl net implies that the size range between $L_{\{25\}}$ and $L_{\{75\}}$ is:
(A) Extremely narrow
(B) Extremely wide
(C) Infinite
(D) Mathematically undefined

NODIA

2013
292. The Schaefer surplus production model structurally assumes that maximum productivity occurs when the population is at:
(A) One half of carrying capacity
(B) Carrying capacity
(C) Near zero biomass
(D) Exactly equivalent to the MSY catch

2024
293. Yield-per-recruit models are particularly useful for fisheries management because they identify the optimal:
(A) Age at first capture and corresponding fishing mortality
(B) Absolute quota in metric tons
(C) Environmental carrying capacity
(D) Time to completely shut down the fishery

2019
294. In Virtual Population Analysis (VPA), replacing a high terminal F value with a low one will generally cause the estimated historical population size to:
(A) Increase significantly
(B) Remain perfectly constant
(C) Decrease significantly
(D) Become entirely zero

2019
295. Maximum Economic Yield (MEY) maximizes the economic rent of a fishery, which generally results in a standing stock biomass that is:
(A) Higher than the biomass at MSY
(B) Lower than the biomass at MSY

(C) Equal to the biomass at MSY
(D) At exactly carrying capacity

2015

296. A Biological Reference Point designated as $F_{\{}\max_{\}}$ is often criticized because harvesting at this exact rate frequently leads to:
(A) Recruitment overfishing by severely depleting the spawning stock
(B) Massive economic hyper-profitability
(C) Extreme increases in natural predation
(D) Growth underfishing

2009

297. In Multispecies VPA (MSVPA), forage fish like sardines generally display an estimated natural mortality curve that:
(A) Decreases linearly with age as they outgrow predator gape sizes
(B) Increases exponentially with age
(C) Remains completely constant at all ages
(D) Is zero for the first three years

2025

298. Ecosim evaluates the impacts of changing fishing effort over time by fundamentally perturbing the:
(A) Steady-state baseline mass-balance established in Ecopath
(B) Exact von Bertalanffy parameters of the apex predator
(C) Temperature gradients across the ecosystem
(D) Spatial coordinates of the fish

NODIA

2018

299. The Length-Based Spawning Potential Ratio (LB-SPR) method relies on the principle that heavy fishing pressure will strictly:
(A) Truncate the size structure and reduce the proportion of mature females
(B) Increase the average length of the population
(C) Force the fish to spawn continuously
(D) Induce immediate genetic mutations for faster growth

2015

300. In the context of the Ecosystem Approach to Fisheries Management (EAFM), a "Stakeholder" is defined as:
(A) Only individuals with valid commercial fishing licenses
(B) Any individual, group, or organization with an interest in or influence over the fishery
(C) Government officials responsible for enforcing maritime law
(D) International buyers of exported fish products

****

ANSWERS

1. (A) Biomass
Biomass represents the total weight of all individuals within a specific fish population or community in a defined geographic area. This metric provides a more comprehensive measure of biological productivity than simple abundance counts because it accounts for the varying sizes and weights of individuals across different life stages and age classes within the ecosystem.

2. (C) Transboundary stock
Transboundary stocks refer to fish populations that physically migrate across the political boundaries of two or more adjacent Exclusive Economic Zones. Unlike straddling stocks, which also move into the high seas, these populations remain within the collective jurisdiction of neighboring coastal states. Cooperative management is essential to ensure sustainable harvest levels and avoid overexploitation across borders.

3. (A) Continuous spawning and rapid growth
Tropical multi-species fisheries are typically characterized by fish that exhibit continuous or protracted spawning periods throughout the year. Due to higher ambient water temperatures, these species generally show more rapid growth rates and higher natural mortality compared to temperate species. This results in complex population structures with overlapping cohorts, making standard age-based stock assessment more challenging.

4. (D) Total body weight
Total body weight is highly susceptible to distortion during specimen preservation in substances like formalin or alcohol. Preservation processes often cause significant dehydration or osmotic changes, leading to weight loss or gain that does not reflect the original state. In contrast, skeletal measurements such as head or standard length remain relatively stable, providing more reliable data for morphometric studies.

5. (B) Strontium:Calcium
The ratio of strontium to calcium in fish otoliths is a critical chemical marker used to reconstruct environmental temperature history. Because strontium incorporation is often inversely related to water temperature, analyzing these ratios across the growth rings allows scientists to trace the thermal environments inhabited by the fish. This method is essential for understanding migration patterns and habitat use.

6. (C) It has a higher mutation rate and lacks recombination
Mitochondrial DNA is highly effective for identifying distinct genetic stocks due to its unique biological properties. It exhibits a much higher mutation rate than nuclear DNA, allowing for the detection of recent population divergences. Furthermore, the absence of recombination and maternal inheritance ensures that genetic lineages remain distinct, providing a clearer historical record of population isolation and connectivity.

7. (D) Population abundance
Catch per Unit Effort is widely used in fisheries science as a relative index of population abundance. The fundamental assumption is that the amount of fish caught is proportional to the density of the stock in the water for a given level of fishing effort. Monitoring trends in this index over time helps managers assess changes in stock size.

8. (D) 3.0
In the mathematical relationship between length and weight, a value of exactly three indicates isometric growth. This means the fish maintains its body shape and specific gravity as it increases in size. When the value deviates from three, the growth is considered allometric, meaning the fish becomes either more elongated or more spherical as it grows larger over time.

9. (B) Resorption and compaction of annuli at the edge
Using scales for age determination becomes increasingly difficult in older individuals of long-lived species. As growth slows down in later life, the annual growth rings, or annuli, tend to become crowded and compacted at the outer edge of the scale. Additionally, physiological stress can lead

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to the resorption of scale material, potentially erasing the clear record of earlier growth.

10. (B) A is true but R is false.
The parameter t-zero in the von Bertalanffy growth model represents the theoretical age at which a fish would have a length of zero. While the assertion correctly defines this mathematical intercept, the reason is incorrect because t-zero is typically a negative value. This adjustment is necessary to account for the rapid growth phase during the early larval period.

11. (A) $\frac{F}{Z}$
The exploitation rate represents the proportion of total mortality that is accounted for by fishing activities. It is mathematically calculated by dividing the instantaneous fishing mortality rate by the total instantaneous mortality rate. This value indicates how heavily a stock is being harvested relative to its natural losses, serving as a critical indicator for assessing potential overfishing in populations.

12. (C) Spawning stock biomass
Pauly's empirical equation for estimating natural mortality is based on several key biological and environmental parameters. It requires the asymptotic length or weight of the species, the growth coefficient from the von Bertalanffy function, and the mean annual environmental temperature. However, spawning stock biomass is a measure of population size and is not used in this specific mortality calculation.

13. (D) Overcompensatory density dependence
The Ricker stock-recruitment model is distinct from other models because it incorporates overcompensatory density dependence. This assumes that at very high levels of spawning stock biomass, the recruitment actually begins to decline. This phenomenon is often attributed to biological factors such as cannibalism of juveniles by adults or the spread of disease within crowded spawning grounds and early nursery areas.

14. (C) Sudden temperature fluctuations
Density-independent factors regulate fish populations regardless of the number of individuals present in a given area. Sudden temperature fluctuations, extreme weather events, or chemical changes in the water can cause significant mortality across the entire population. Unlike competition or disease, the impact of these environmental stressors does not change based on how many fish are living in the habitat.

15. (B) L50
The parameter L-fifty refers to the specific body length at which exactly fifty percent of the fish that encounter a fishing gear are retained. This measurement is a fundamental component of gear selectivity studies, particularly for nets. It helps managers determine the appropriate mesh size needed to allow juvenile fish to escape while ensuring that mature individuals are harvested.

16. (D) Parabolic
The Schaefer surplus production model assumes a specific mathematical relationship between fishing effort and sustainable yield. Based on the logistic growth equation, this model predicts that yield will follow a symmetrical parabolic curve. Yield increases with effort up to a peak, known as the maximum sustainable yield, after which further increases in fishing effort lead to declining catch levels.

NODIA

17. (A) Constant above the age of first capture
The Beverton and Holt yield-per-recruit model simplifies complex fishery dynamics by assuming that fishing mortality remains constant for all fish once they reach the age of first capture. This model focuses on how the harvest varies with changes in fishing pressure and the age at which fish are first targeted, assuming that natural mortality remains stable throughout their lifespan.

18. (C) Catch is taken exactly halfway through the year
Pope's cohort analysis provides a simplified mathematical approach to virtual population analysis by assuming that the entire annual catch is taken as a single pulse in the middle of the year. This assumption simplifies the exponential decay equations used to reconstruct historical population sizes. It remains highly accurate as long as the total mortality rate is not excessively high.

19. (C) Less than the effort at MSY
Maximum Economic Yield represents the level of fishing effort that generates the largest difference between total revenue and total cost. Because of the increasing costs associated with higher levels of fishing activity, this economic optimum

always occurs at a lower level of effort than the maximum sustainable yield. Harvesting at this level ensures higher profitability and greater ecological safety.

20. (D) P-3, Q-1, R-2, S-4
Fishery reference points serve as critical benchmarks for management decisions. Limit reference points define boundaries to avoid stock collapse, while target reference points indicate desired optimal states for sustainability. F-max represents the fishing mortality maximizing yield per recruit, whereas F-zero-point-one is a more conservative measure where the marginal yield is ten percent of its initial value at the origin.

21. (B) Predator-prey dynamics
The Lotka-Volterra equations are a pair of first-order nonlinear differential equations frequently used to describe the dynamics of biological systems where two species interact. Specifically, they model the relationship between a predator and its prey. These equations illustrate how the populations of both species fluctuate in linked cycles over time, driven by predation rates and the availability of food.

22. (C) Production equals consumption plus mortality and export
In ECOPATH modeling, the mass-balance assumption requires that the energy or biomass entering a functional group must be accounted for by the energy leaving it. This means the total production of a group is balanced by the sum of its consumption by other groups, natural and fishing mortality, and any biomass exported or accumulated within the system over time.

23. (D) Data is limited to length frequencies and life history
Length-based spawning potential ratio is a robust tool designed for data-limited fisheries where extensive age-structure information is unavailable. This method relies on length-frequency data from the catch and a few key life-history parameters, such as the ratio of natural mortality to growth. It allows managers to estimate the degree of spawning biomass depletion relative to an unfished state.

24. (A) ELEFAN
ELEFAN is a widely used algorithm within the FiSAT II software package specifically developed to extract growth parameters from length-frequency data. It works by identifying and following the progression of modal peaks in size distributions over time. By fitting a von Bertalanffy growth curve to these peaks, it provides estimates of maximum length and the growth curvature coefficient.

25. (B) Unit stock
A unit stock is an operational concept in fisheries management describing a group of fish of the same species that inhabit a specific area. These individuals are assumed to have similar life-history characteristics and exhibit random mating within the group. For assessment purposes, the stock is treated as a discrete unit with homogeneous parameters for growth, mortality, and recruitment.

26. (B) UNCLOS
The management and conservation of highly migratory fish stocks, such as tunas and billfishes, are primarily governed by the United Nations Convention on the Law of the Sea. This international framework establishes the legal obligations of nations to cooperate through regional organizations. These efforts ensure the sustainable use of species that travel across vast distances and multiple national jurisdictions.

27. (A) Lack of clear seasonal growth rings on hard parts
A major challenge in assessing tropical fish stocks using temperate models is the difficulty in determining age. In tropical waters, the lack of significant seasonal temperature variation often results in the absence of clear, well-defined annual growth rings on hard parts like otoliths and scales. Consequently, scientists must often rely on length-frequency analysis to estimate growth and mortality parameters.

28. (C) Providing a two-dimensional geometric shape representation
Truss network analysis improves upon traditional morphometrics by utilizing a systematic grid of measurements across the entire body of the fish. By mapping distances between homologous landmarks, it creates a two-dimensional geometric representation of shape. This approach captures variations in body depth and form more effectively than simple linear measurements, providing better discrimination between different fish populations or stocks.

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29. (D) Genetically fixed and environmentally modified
Otolith shape is a powerful tool for stock delineation because it is influenced by both biological and environmental factors. While the basic blueprint for the shape is genetically determined, it is also modified by the specific environmental conditions the fish experiences during its growth, such as temperature and diet. This unique combination makes otolith shape a reliable marker for identifying distinct stocks.

30. (B) I and III
Microsatellites are highly effective genetic markers characterized as short tandem repeats of DNA sequences. They are extremely valuable in fisheries research because they are highly polymorphic, meaning they vary significantly between individuals and populations. While they have high mutation rates, they provide the fine-scale resolution necessary to distinguish between closely related stocks and analyze population structure within a species.

31. (B) Standardize sampling gear and randomized design
Fishery-independent surveys are preferred for generating abundance indices because they utilize scientific research vessels and standardized sampling protocols. Unlike commercial fishing, which targets areas of high density, these surveys use randomized or stratified designs to cover the entire species range. This approach minimizes the spatial and operational biases inherent in commercial catch data, providing a more accurate reflection of population trends.

32. (D) $K = \frac{W}{L^3} \times 100$
Fulton's condition factor is a mathematical expression used to assess the relative well-being or "fatness" of a fish. It is calculated by dividing the weight of the fish by the cube of its length, then multiplying by a constant. This index assumes isometric growth and allows researchers to compare the physiological state of fish across different seasons or environmental conditions.

33. (B) Differences between empirical weight and theoretical expected weight for a given length
The relative condition factor is a specialized index designed to account for deviations from isometric growth. It is calculated as the ratio of the observed weight of a fish to the weight predicted by a length-weight relationship for that specific population. This allows for a more accurate assessment of a fish's condition by considering its actual growth pattern rather than a cube.

34. (C) Highly restricted and discrete spawning seasons
Length-frequency analysis is most effective for estimating age and growth in species that have discrete, well-defined spawning seasons. Such restricted spawning produces clear, distinct cohorts that appear as separate modal peaks in size histograms. Following these peaks over time allows researchers to track the growth of specific age groups, which is much more difficult in species with continuous year-round spawning.

35. (A) Rate at which length approaches the asymptote
In the von Bertalanffy growth function, the parameter K represents the curvature coefficient. It describes the rate at which the fish's length approaches the maximum theoretical size, known as the asymptote. A high K value indicates that the fish grows quickly toward its maximum size and typically has a shorter lifespan, while a low K value suggests a slower growth rate.

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36. (D) $Z = M + F$
Total mortality represents the instantaneous rate at which individuals are removed from a population due to all causes. It is mathematically defined as the sum of two components: natural mortality, which includes deaths from predation, disease, and old age, and fishing mortality, which results from harvesting. Understanding the relationship between these parameters is fundamental to assessing the impact of fishing on stocks.

37. (B) Maximum observed age
Hoenig's empirical method is a widely used technique for estimating the natural mortality rate of a fish stock. This method is based on the biological premise that there is a strong inverse relationship between natural mortality and longevity. By utilizing the maximum observed age of individuals within a population, the formula provides a reliable estimate of mortality for data-limited species.

38. (C) Catch is taken exactly halfway through the year
A linearized catch curve is a graphical tool used to estimate the total mortality rate of a population. It is constructed by plotting the natural logarithm of the number of fish in each age class, or catch per unit age, against their respective ages. The negative slope of the descending limb of this curve provides a direct estimate of the instantaneous mortality.

39. (D) Starvation and competition for limited resources
In the Beverton-Holt stock-recruitment model, the number of recruits approaches an upper limit as the spawning stock biomass increases. This asymptotic behavior is driven by density-dependent processes occurring during the early life stages. As the population becomes more crowded, competition for limited food and suitable habitat increases, leading to higher mortality rates from starvation and reducing the overall survival of recruits.

40. (D) I, II and IV
The Schaefer surplus production model is built on several key assumptions. It assumes that population growth follows a logistic curve and that the catchability coefficient remains constant over time. It also presumes that the population responds immediately to changes in fishing pressure or environment. However, it is a biomass-aggregate model and does not account for the age-structured dynamics of the population.

41. (B) Retention given the length of the fish
A logistic selection curve is a mathematical function used to describe the selectivity of fishing gear like trawl nets. It represents the probability that a fish of a certain length will be retained by the gear once it has been encountered. The curve typically shows that the probability of retention increases with length, reaching fifty percent at a specific point.

42. (B) Exponential
The Fox surplus production model is an alternative to the Schaefer model that utilizes an exponential relationship between catch per unit effort and fishing effort. This model produces an asymmetrical production curve where the maximum sustainable yield occurs at a lower biomass level. It is often considered more appropriate for stocks that show a slower decline in productivity at higher effort levels.

43. (A) Utilizing age- or length-specific arrays for modeling
The Thompson and Bell model is an analytical approach that differs from basic yield-per-recruit models by using detailed age- or length-specific data. It incorporates arrays of fishing mortality, natural mortality, and mean weights for each size group. This allows managers to predict how changes in fishing pressure and gear selectivity will affect both the total yield and the economic value.

44. (B) Backward from the oldest age class to the youngest
Virtual population analysis is a method for reconstructing the historical size of a fish cohort. The calculations proceed backward in time, starting from the oldest age class in the most recent year and moving toward the youngest. By using catch-at-age data and an assumed natural mortality rate, the model estimates the number of individuals that must have been alive.

45. (D) Surplus production is maximized
Maximum Sustainable Yield is a fundamental concept in fisheries management representing the largest average catch that can be continuously taken from a stock. On a production curve, this point occurs where the surplus production, which is the net growth of the population, is at its highest. At this level, the harvest exactly balances the population's natural ability to replenish itself.

46. (C) Growth overfishing
Biological reference points such as F-zero-point-one are specifically designed to prevent growth overfishing. This type of overfishing occurs when fish are harvested at an average size that is smaller than the size that would produce the maximum yield per recruit. By setting conservative fishing mortality targets, managers ensure that individuals are allowed to grow sufficiently before being captured by the gear.

47. (B) Predation mortality (M2) internally
Multispecies virtual population analysis is an advanced modeling approach that expands on single-species methods by explicitly accounting for trophic interactions. Its primary feature is the internal calculation of predation mortality, often

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denoted as M-two. By incorporating stomach content data, the model estimates how much of a prey stock is consumed by predators, providing a more realistic assessment of total mortality.

48. (D) Consumed or exported from the system
In an ECOPATH model, ecotrophic efficiency is a critical parameter that represents the fraction of a group's total production that is utilized within the ecosystem. This includes the biomass that is consumed by predators or harvested by fisheries. A value close to one indicates that almost all production is being used, while a lower value suggests that more production is lost.

49. (A) Carrying capacity and intrinsic growth rate
Data-limited catch-only models, such as Catch-MSY, are designed to estimate fishery status when only historical catch records are available. These models utilize the catch time series along with prior information regarding the stock's resilience, specifically its intrinsic growth rate and carrying capacity. By simulating various population trajectories, they identify the most likely parameters that are consistent with the observed harvest.

50. (B) I and II
Modern R-based tools like TropFishR are designed to enhance rather than replace traditional stock assessment models. While they provide transparent and reproducible workflows, they still require a level of user coding knowledge to operate effectively. These tools integrate advanced versions of classic methodologies, such as ELEFAN, and use sophisticated statistical estimators to improve the accuracy of growth and mortality estimates.

51. (B) Is an operational management concept with homogeneous parameters
A unit stock is primarily an operational concept used by fisheries managers to define a group of fish that can be treated as a single population. While biological populations are defined by reproductive isolation, a unit stock is defined by having homogeneous parameters for growth, mortality, and recruitment. This allows for consistent assessment and management within a specific geographic area or fishery.

52. (B) Bilateral or multilateral cooperative agreements
Management of transboundary stocks requires international cooperation because these fish populations move between the Exclusive Economic Zones of different nations. Successful management is typically achieved through bilateral or multilateral agreements where countries share data and coordinate their harvest strategies. Without such cooperation, there is a significant risk of competitive overexploitation, leading to the eventual collapse of the shared resource.

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53. (A) Distinct, non-overlapping cohorts
Tropical multi-species fisheries are rarely characterized by distinct, non-overlapping cohorts. Because many tropical species spawn continuously or over very long seasons, new recruits are constantly entering the population. This leads to a complex size structure where different age groups blend together, making it very difficult to distinguish separate cohorts in length-frequency data compared to species in more seasonal temperate environments.

54. (D) Countable traits such as fin rays or scales
Meristic characteristics refer to morphological traits in fish that can be described using discrete integer counts. Common examples include the number of fin rays, scales along the lateral line, or the number of vertebrae. These traits are often determined early in a fish's development and remain constant throughout its life, making them useful tools for distinguishing between different populations or species.

55. (B) Diadromous migrations
Strontium isotope signatures in fish otoliths are exceptionally useful for identifying diadromous migrations. Because the isotopic ratio of strontium in water varies significantly between freshwater and marine environments, the chemical composition of the otolith reflects the salinity of the habitat where the fish was living. Analyzing these signatures allows researchers to track movements between rivers and the ocean during a fish's lifecycle.

56. (C) Protein mobility in an electric field
Allozyme electrophoresis is a biochemical technique used for stock identification that relies on variations in enzymes. It measures the mobility of different protein variants, or allozymes, as they

move through a gel in an electric field. Because these variations are genetically determined, differences in the frequencies of these proteins between groups of fish can indicate the presence of distinct, isolated breeding stocks.

57. (D) Changes in gear efficiency and spatial distribution
Standardizing catch per unit effort is essential because raw data is often influenced by factors unrelated to fish abundance. Changes in fishing technology, such as improved sonar or gear efficiency, can increase catch rates even if the stock is declining. Additionally, if a fleet shifts its spatial distribution to target dense aggregations, the raw CPUE may stay high while the overall population decreases.

58. (A) Negative allometric growth
A length-weight exponent value of two-point-seven indicates that a fish exhibits negative allometric growth. This means that as the fish increases in length, it does not gain weight at a proportional rate, resulting in a body shape that becomes relatively more slender or elongated. This is a common growth pattern for many species and contrasts with isometric growth where the exponent is three.

59. (D) Fish length and hard part radius
Back-calculating fish length from hard parts like scales or otoliths is based on the fundamental assumption of a proportional relationship between the growth of the fish and the growth of the calcified structure. By measuring the distance from the center to various annual rings, researchers can estimate the length the fish had reached at previous ages, providing valuable historical growth data.

60. (B) II, I, IV, III
The standard sequence for performing length-frequency analysis using the ELEFAN method begins with plotting the raw histograms to visualize the data. Next, the data is restructured to emphasize the peaks and troughs. Then, von Bertalanffy growth curves are fitted to these restructured peaks. Finally, the goodness-of-fit is evaluated to identify the parameters that maximize the alignment with the data structure.

61. (B) Maximum growth rate
In the von Bertalanffy growth function for weight, the point of inflection on the curve identifies the age at which the fish is growing most rapidly. At this specific point, the absolute increase in weight per unit of time reaches its maximum before the growth rate begins to slow down as the fish approaches its maximum theoretical weight. This point is a significant biological milestone.

62. (C) Estimation of total mortality (Z)
The descending right limb of a catch curve represents the portion of the population that is fully recruited to the fishing gear. By calculating the negative slope of this limb when plotted on a semi-logarithmic scale, researchers can estimate the instantaneous rate of total mortality. This method assumes that recruitment and mortality have remained relatively constant for the age groups represented in the sample.

63. (C) Maximum age and the VBGF parameter K
Taylor's empirical formula is a method used to estimate the natural mortality rate of a fish stock. This specific formula utilizes two primary biological parameters: the maximum age reached by individuals in the population and the curvature parameter from the von Bertalanffy growth function. It provides a way to estimate mortality for species where direct measurements are difficult but growth data exists.

64. (D) Recruitment decreases
The descending limb of a Ricker stock-recruitment curve represents a scenario where further increases in the spawning stock biomass lead to a reduction in the total number of recruits. This overcompensatory behavior suggests that high densities of adults or eggs create negative feedback, such as through intense competition for nursery space or increased rates of cannibalism, which ultimately reduces survival.

65. (B) Maximum limit of fish biomass the environment can sustain
Carrying capacity refers to the maximum biomass of a fish population that a specific environment can support over the long term. This limit is determined by the availability of essential resources such as food, habitat, and oxygen. When a population reaches this level, its growth rate naturally slows to zero as mortality and recruitment balance out due to density-dependent competition.

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66. (C) Shift the size of first capture to larger lengths
Mesh size regulations are a primary management tool used to control the selectivity of fishing gear. By increasing the size of the openings in a net, managers ensure that smaller, juvenile fish can escape, thereby shifting the size of first capture to larger individuals. This strategy helps prevent growth overfishing and allows more fish to reach maturity and contribute to the spawning biomass.

67. (D) The asymmetry of the production curve
The Pella-Tomlinson surplus production model is a generalized version of simpler models that includes an additional shape parameter. This parameter determines the degree of asymmetry in the production curve, allowing the maximum sustainable yield to occur at various levels of carrying capacity. This flexibility makes the model more adaptable to different species that may not follow a perfectly symmetrical growth pattern.

68. (A) The relationship between spawning stock and recruitment
A significant limitation of the yield-per-recruit model developed by Beverton and Holt is its failure to account for the relationship between the size of the spawning stock and subsequent recruitment. The model assumes that recruitment remains constant regardless of how much the parent stock is reduced by fishing. Consequently, it cannot predict or prevent recruitment overfishing, which is a major management concern.

69. (B) The catch in that interval and the survivors in the next
In cohort analysis, the number of individuals alive at the start of a specific age interval is reconstructed using a backward calculation. This process requires data on the total catch taken during that interval and the estimated number of survivors that were still alive at the beginning of the subsequent age group. By iterating this process, researchers can estimate historical population sizes.

70. (A) III, II, I, IV
Fishing mortality reference points follow a logical hierarchy based on the intensity of harvest. F-zero-point-one is the most conservative target, followed by F-MSY, which represents the level for maximum sustainable yield. F-max is generally higher, representing the peak of the yield-per-recruit curve. Finally, F-crash is the highest level, signifying the point at which the population can no longer sustain itself.

71. (B) A decline in the prey population
In the classic Lotka-Volterra predator-prey model, an increase in the predator population leads directly to a higher rate of predation. This increased pressure causes a decline in the prey population as more individuals are consumed. As the prey population drops, the predators eventually face food shortages, illustrating the interconnected and oscillating nature of these two populations within an ecosystem.

72. (C) Time-dynamic simulations of biomass
ECOSIM is an extension of the static ECOPATH framework that allows for time-dynamic simulations of an ecosystem. By using differential equations, it models how the biomass of various functional groups changes over time in response to factors such as fishing pressure and environmental variations. This dynamic approach enables managers to predict the long-term ecological consequences of different management strategies.

73. (D) Unfished spawning biomass remaining under current fishing levels
The spawning potential ratio is a measure used to evaluate the health of a fish stock relative to its unfished state. It is defined as the proportion of the lifetime spawning biomass per recruit that remains under the current level of fishing mortality compared to what would exist if there were no fishing. This index is a critical indicator of recruitment overfishing.

74. (A) Length-frequency based stock assessment routines
FiSAT II is a specialized software package widely used for the assessment of tropical fish stocks. Its primary feature is a suite of routines designed for analyzing length-frequency data, which is often the only type of information available in these fisheries. These tools allow researchers to estimate vital parameters such as growth rates, mortality, and gear selectivity without requiring age data.

75. (A) Overexploitation or localized depletion
Defining a unit stock based on political boundaries rather than biological ones can lead to serious management failures. If a single

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is thermodynamically impossible and indicates that the model is unbalanced. This often means that the input data for biomass, production, or consumption needs to be adjusted.

149. (B) Sequential collapse of high-value species followed by lower-value species
Serial depletion is a phenomenon observed in multi-species fisheries where fleets target different species in a specific order. Typically, high-value, large-bodied species are targeted and overfished first. Once their populations collapse, the fishery shifts its effort to progressively lower-value and smaller species. Monitoring the sequence of species collapses in the catch is the primary way to detect this destructive pattern of exploitation.

150. (C) A is false but R is true.
ELEFAN is a length-based method rather than an age-based one using hard parts like scales. It operates by identifying and tracing the progression of modal peaks in length-frequency distributions over time. By optimizing the goodness-of-fit, it estimates the growth parameters of the von Bertalanffy equation, making it highly valuable for data-limited tropical fisheries.

151. (A) Regional Fisheries Management Organizations (RFMOs)
Because highly migratory stocks like tuna travel across vast ocean basins and multiple national boundaries, their management cannot be handled by any single nation alone. Instead, it requires cooperation through Regional Fisheries Management Organizations. these international bodies bring together all the nations involved in the fishery to share data, conduct assessments, and set coordinated harvest limits to ensure the sustainable use of the shared resource.

152. (A) Earlier age at maturity and rapid turnover
Tropical fish stocks often possess biological traits that make them inherently more resilient to fishing pressure than many temperate species. Due to higher water temperatures, these fish generally exhibit more rapid growth and reach sexual maturity at a much younger age. This rapid population turnover allows them to replenish their numbers more quickly, although they are still vulnerable to overexploitation if fishing pressure is excessive.

153. (A) A catch of multiple populations managed as one unit
A mixed stock fishery occurs when a single fishing operation harvests individuals from several different populations or species that are managed as a single unit. This situation is common in many coastal and oceanic fisheries. The primary challenge is that each population may have different levels of productivity, and a single management strategy can easily lead to the overexploitation of the most vulnerable stocks.

154. (A) Photographing the specimen and digitizing homologous landmarks
Truss network analysis is a specialized morphometric technique that begins with capturing high-quality images of the fish specimen. Researchers then identify and digitize a set of homologous anatomical landmarks across the body. These points serve as the basis for a systematic grid of measurements that describe the fish's two-dimensional shape. This precise digital approach allows for detailed and objective comparisons of body form between different stocks.

155. (A) The ratio of Oxygen-18 to Oxygen-16
The ratio of oxygen isotopes incorporated into the calcium carbonate of fish otoliths is a powerful tool for reconstructing past environmental conditions. Because the incorporation of these isotopes is temperature-dependent, the ratio of Oxygen-eighteen to Oxygen-sixteen serves as a natural thermometer. By analyzing these ratios across the growth layers of the otolith, scientists can determine the precise temperature history experienced by the fish throughout its life.

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156. (C) Divergent allele frequencies due to drift and selection
Genetic stock identification is based on the principle that isolated populations will naturally accumulate genetic differences over time. In the absence of interbreeding, processes such as genetic drift and natural selection cause the frequencies of different alleles to diverge. By measuring these allele frequencies, researchers can determine whether groups of fish belong to the same breeding population or represent distinct, genetically isolated stocks.

component parts. It identifies the individual normal distributions that represent distinct age groups or cohorts within the population. This decomposition allows researchers to estimate the mean length and abundance of each age class, which is essential for calculating growth and mortality.

85. (B) Difference between asymptotic length and current length
The fundamental assumption of the von Bertalanffy growth function is that the rate at which a fish increases in length is proportional to the remaining growth potential. Specifically, as a fish grows closer to its maximum theoretical size, or asymptotic length, its growth rate slows down. This relationship produces the characteristic curve where growth is rapid initially and then gradually levels off.

86. (C) Equal to the natural mortality
An exploitation rate of zero-point-five indicates that fishing mortality is exactly equal to natural mortality. In many classical fishery models, this level has been used as a rough rule of thumb for identifying the maximum sustainable yield. It suggests that the total deaths in the population are evenly split between those caused by harvesting and those occurring from natural processes.

87. (D) Maximum theoretical length (L_∞)
In Pauly's empirical equation, the maximum theoretical length has a negative influence on the estimated natural mortality rate. This reflects the general biological principle that larger-bodied species tend to have lower natural mortality and longer lifespans. Conversely, factors like higher environmental temperature and a higher growth coefficient are positively correlated with mortality, as they typically indicate faster-paced life histories.

88. (B) Incompletely selected by the fishing gear
The ascending left limb of a catch curve represents the younger age classes that are not yet fully vulnerable to the fishing gear. These individuals are either too small to be retained by the mesh or inhabit different areas than the main fishery. Because they are incompletely selected, their abundance in the sample does not accurately reflect their true numbers in the population.

89. (B) Habitat space determines the maximum number of recruits
The Beverton-Holt stock-recruitment model is most appropriate for species where the number of recruits is limited by available habitat or resources. In this model, recruitment increases with spawning stock size but eventually reaches an asymptote. This suggests that once all suitable nursery areas are occupied, any additional eggs or larvae produced will not survive, regardless of the size of the spawning stock.

90. (A) P-2, Q-4, R-1, S-3
Surplus production models vary in how they represent population dynamics. The Schaefer model uses a symmetrical parabolic curve, while the Fox model features an exponential decline in catch per unit effort. The Pella-Tomlinson model allows for an asymmetric production curve by adding a shape parameter. Finally, Catch-MSY is a specialized tool designed for data-limited scenarios using historical catch time series.

91. (B) An acute environmental hypoxia event
Density-independent mortality is caused by external factors that affect a population regardless of its size. An acute environmental hypoxia event, where oxygen levels suddenly drop, is a perfect example. Such events can cause massive, non-selective mortality across all individuals in an area. Unlike competition or disease, the impact of these environmental stressors does not change based on how many fish are present.

92. (B) Fish mouth size and hook size
The selection ogive for longline gear is primarily determined by the relationship between the size of the fish's mouth and the size of the hook used. Larger hooks tend to catch larger fish, while smaller fish may be unable to take the hook or may not be effectively hooked. This relationship defines which part of the population is vulnerable to the gear.

93. (A) Assuming catch equals equilibrium yield during expansion
A common error when applying surplus production models to developing fisheries is the assumption that the observed catch represents the equilibrium yield. During the expansion phase of a fishery, high catches are often taken from the accumulated biomass of an unfished stock. These temporary "windfall" catches are

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biological population is managed as multiple independent units, or if distinct populations are merged, it can result in overexploitation or localized depletion. This occurs because the management actions do not align with the actual productivity and movement patterns of the fish.

76. (B) They are caught by multiple nations with varying data qualities
Highly migratory stocks present a unique challenge for assessment because they travel across the jurisdictions of many different countries and the high seas. This means that data on catches and effort must be collected from multiple nations, often with varying levels of accuracy and completeness. Coordinating these diverse data sources is essential for a reliable assessment of the entire stock.

77. (A) Higher K values in the VBGF
Tropical pelagic fishes generally exhibit life history traits characterized by rapid growth and high turnover rates. In the von Bertalanffy growth function, this is reflected in higher K values compared to temperate demersal species. These fish typically reach their maximum size more quickly, mature at an earlier age, and have shorter lifespans, which influences how they respond to fishing pressure.

78. (D) Homologous anatomical landmarks
Truss network analysis involves a systematic series of measurements taken between specific homologous anatomical landmarks on the body of a fish. These landmarks are fixed points that can be reliably identified across different individuals, such as the base of fins or the tip of the snout. By mapping these distances, researchers can capture detailed information about the body shape for stock identification.

79. (D) The ambient water chemistry during deposition
Chemical stock delineation is based on the principle that the chemical composition of calcified structures like otoliths reflects the environment in which the fish lived. As layers of calcium carbonate are deposited, trace elements from the surrounding water are incorporated into the structure. These chemical signatures serve as a permanent record of the ambient water chemistry, allowing researchers to distinguish between different stocks.

80. (A) Both A and R are true and R is the correct explanation of A.
Microsatellite markers are exceptionally effective for fine-scale population analysis in fisheries. The assertion is correct because these markers provide high resolution due to their polymorphic nature. The reason accurately explains this effectiveness by noting that their rapid mutation rates create significant genetic variation, allowing scientists to detect subtle differences between closely related populations that other markers might miss.

81. (B) Non-representative spatial coverage driven by fisher behavior
Fishery-dependent data is inherently biased because it is collected from commercial operations rather than scientific surveys. Fishers do not sample randomly; instead, they target specific areas where they expect to find the highest concentrations of fish. This behavior results in non-representative spatial coverage, as large areas may be completely unsampled, leading to potential overestimation of abundance and other stock parameters.

82. (C) Heavier than the average expected for its length
A relative condition factor significantly greater than one indicates that an individual fish is in excellent physical condition. Specifically, it means the fish weighs more than the average weight expected for its length within that population. This suggests that the fish has had access to abundant food resources and is exhibiting healthy growth, contrasting with values below one which indicate undernourishment.

83. (A) Rapid, active growth
The formation of opaque zones in fish otoliths is typically associated with periods of rapid and active growth. These zones contain a higher proportion of organic matrix relative to calcium carbonate, which makes them appear darker under transmitted light. In many species, these zones are deposited during the warmer months when food is plentiful and metabolic rates are at their peak.

84. (A) Decompose mixed length distributions into normal cohorts
Bhattacharya's method is a statistical technique used in length-frequency analysis to separate a complex, multi-modal distribution into its

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and potential collapse of the least productive species within the complex, even if the total catch remains stable.

103. (C) Catch-MSY
Catch-MSY is a specialized stock assessment approach specifically developed for data-limited situations. This method relies entirely on a time series of historical catch data and prior estimates of the stock's resilience or intrinsic growth rate. By using these inputs, the model identifies potential trajectories for biomass and estimates management reference points such as maximum sustainable yield and current stock status.

104. (C) Cohorts overlap heavily, blurring distinct modal progressions
Continuous spawning in tropical regions presents a major obstacle for length-frequency analysis. Unlike temperate species that have discrete spawning events, tropical fish often produce recruits throughout the year. This results in heavily overlapping cohorts where individual age groups cannot be easily distinguished as separate peaks in size histograms. This blurring makes it difficult to track the growth and mortality of specific cohorts.

105. (D) It necessitates precise landmark placement and specialized image software
While truss network analysis provides a superior representation of body shape compared to traditional morphometrics, it is more technically demanding. It requires the precise identification and placement of homologous landmarks on the specimen, followed by the use of specialized imaging software to calculate the distances between them. This increased complexity and requirement for technical expertise are significant disadvantages in some field studies.

106. (A) Migration between freshwater and marine environments
Sudden changes in the concentration of elements like barium and strontium in fish otoliths are clear indicators of environmental shifts. Because these elements occur in different concentrations in freshwater and seawater, a sharp spike or drop in their ratios along an otolith transect signals that the fish has migrated between these environments. This allows researchers to reconstruct the migratory history of individuals.

107. (C) Microsatellites
Microsatellites are powerful genetic markers that are widely used in fisheries research. They are characterized as being codominant and biparentally inherited, meaning they reflect genetic contributions from both parents. Because they are highly polymorphic and have high mutation rates, they provide the fine-scale resolution necessary to distinguish between closely related stocks and to analyze the complex genetic structure of fish populations.

108. (C) Scientific research trawl surveys
Scientific research trawl surveys are a classic example of fishery-independent data collection. These surveys are conducted by research vessels using standardized gear and a randomized sampling design, ensuring that the data is not biased by the behavior of commercial fishers. This approach provides a more objective and accurate index of fish abundance and distribution than data derived from commercial catch records.

109. (A) Remain perfectly constant throughout growth
Isometric growth is a mathematical concept where a fish's dimensions increase at the same relative rate as it grows. If a fish grows isometrically, it is assumed that its body shape and specific gravity remain perfectly constant throughout its entire life. This means that a large fish is essentially a perfectly scaled-up version of a smaller one, which simplifies many biological and mathematical calculations.

110. (D) III only
Length-frequency analysis is a valuable tool in fisheries science, but it has specific limitations. It is most effective when cohorts are distinct and well-separated, rather than highly overlapping. In species with continuous spawning, the overlapping of cohorts makes it extremely difficult to track modal progressions. The other methods, such as otolith and scale reading or tag-recapture, are correctly described in terms of their strengths.

111. (A) The growth rate theoretically equals zero
In the von Bertalanffy growth function, the parameter L-infinity represents the maximum theoretical length that a fish can reach. Biologically, this is the size at which the rate of length growth effectively becomes zero. While individual fish may vary in size, this parameter

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not sustainable and do not reflect the long-term surplus production of the population.

94. (C) Changes in economic value and mesh size regulations
The Thompson and Bell analytical model is a versatile management tool because it can easily incorporate both biological and economic data. It allows managers to simulate the effects of different mesh size regulations and changes in fishing pressure on the total yield. Additionally, by including market prices, it can predict how these changes will affect the total economic value of the catch.

95. (A) Terminal fishing mortality
Virtual population analysis is highly sensitive to the assumed value of terminal fishing mortality, which is the mortality rate for the oldest age class or the most recent year. Because the model calculates population sizes backward from this starting point, any error in the terminal value is propagated through the entire reconstruction. Calibrating this parameter is therefore a critical step.

96. (B) Economic, social, and ecological factors
Optimum Yield is a management objective that goes beyond the purely biological goal of Maximum Sustainable Yield. It is defined as the amount of fish that will provide the greatest overall benefit to the nation, explicitly incorporating economic, social, and ecological factors. This approach allows for trade-offs, such as reducing harvest levels to protect the ecosystem or to ensure higher profitability.

97. (B) A safe operational biological and economic target
Target reference points are intended to provide fisheries managers with a clear objective for the desired state of a stock. These points represent levels of fishing mortality or biomass that are considered safe, sustainable, and economically optimal. By aiming for these targets, managers can ensure the long-term health of the resource while providing stable benefits to the fishing industry and society.

98. (B) Suitability coefficients and predation mortality
In multispecies virtual population analysis, stomach content data is a fundamental input used to estimate trophic interactions. By analyzing what predators eat, the model calculates suitability coefficients, which describe the preference of a predator for a specific prey. This information is then used to estimate predation mortality, providing a much more accurate picture of the total mortality affecting prey stocks.

99. (A) Top-down versus bottom-up control between predator and prey
The vulnerability parameter in ECOSIM is a key factor that regulates the strength of interactions between predators and their prey. It determines whether the system is primarily driven by top-down control, where predators limit prey abundance, or bottom-up control, where prey availability limits predator growth. Adjusting this parameter allows the model to better reflect the specific dynamics of different marine ecosystems.

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100. (A) I and II
Length-based spawning potential ratio is a valuable tool for assessing data-limited fisheries. It is specifically designed to work with size composition data from the catch, rather than requiring absolute abundance estimates. However, the model assumes that the stock is in a steady state, meaning that recruitment and fishing pressure have remained relatively constant over the period represented by the sample.

101. (A) Using genetic optimization algorithms to fit growth curves
The TropFishR package in R represents a modern advancement in fisheries science by improving upon traditional length-frequency methods. It utilizes sophisticated genetic optimization algorithms to fit von Bertalanffy growth curves to data, providing more robust and objective parameter estimates than the older manual methods. This approach also allows for the calculation of confidence intervals, enhancing the reliability of the stock assessment.

102. (A) Overharvesting of the least productive species
Managing a mixed stock fishery as a single unit can lead to serious ecological consequences. If different species with varying productivity levels are caught together, a common harvest rate may be sustainable for some but far too high for others. This often results in the overharvesting

121. (A) Unacceptable and warrants immediate management action
A limit reference point signifies a critical boundary in a fishery that should not be crossed. If a stock's biomass falls below this level or if fishing mortality exceeds it, the state of the fishery is considered unacceptable and potentially dangerous to the stock's survival. Reaching a limit reference point serves as a "red flag" that necessitates immediate and decisive management intervention.

122. (B) Total production of group i utilized within or exported from the system
In the ECOPATH mass-balance equation, the product of biomass, the production-to-biomass ratio, and ecotrophic efficiency represents the portion of a functional group's total production that is actually used within the ecosystem. This include the amount consumed by higher trophic levels, the amount harvested by fisheries, and any biomass that is exported. It excludes the production that eventually becomes detritus.

123. (A) Mean length of catch relative to length at maturity
In data-limited fisheries where direct measurements of spawning stock biomass are unavailable, the mean length of the catch is often used as a practical proxy. By comparing the average size of the fish being harvested to their known length at maturity, managers can assess whether enough individuals are surviving to reproduce. A declining mean length can indicate that the spawning stock is being depleted.

124. (B) L_∞ and $\frac{Z}{K}$
The Powell-Wetherall plot is a graphical technique integrated into the FiSAT II software for analyzing length-frequency data. It is primarily used to estimate two critical parameters: the maximum theoretical length, or L-infinity, and the ratio of total mortality to the growth coefficient. This method is particularly valuable because it can be used even when the total mortality and growth are not individually known.

125. (B) International Exclusive Economic Zone boundaries
A transboundary stock is defined by its physical movement across the borders of different national jurisdictions. Specifically, these are fish populations that migrate between the Exclusive Economic Zones of two or more neighboring countries. Because these stocks are a shared resource, their management requires international cooperation and formal agreements to ensure that the total harvest remains sustainable for all parties involved.

126. (A) Longer lifespan and later age at maturity
Temperate groundfish, such as cod and haddock, typically exhibit life history traits that contrast sharply with those of small pelagic species. These demersal fish generally have much longer lifespans and reach sexual maturity at a later age. Their slower turnover rates and longer generational times mean they may be more vulnerable to overexploitation and take longer to recover if their populations are depleted.

127. (B) Tagging and recapture analysis
Tagging and recapture analysis provides the most direct and reliable measurement of somatic growth in individual fish. By measuring a fish at the time of release and again when it is recaptured, researchers can calculate the exact increase in length or weight over a known period. This direct observation avoids the assumptions and potential errors associated with interpreting marks on calcified structures.

128. (C) Principal Component Analysis (PCA)
Principal Component Analysis is the most common statistical method used to analyze the large datasets generated by truss network studies. This multivariate technique reduces the complexity of the data by identifying the major patterns of variation in body shape. By projecting the measurements into a few principal components, researchers can easily visualize and distinguish between different stocks or populations based on their morphology.

129. (B) Elements deposited are not reabsorbed
The fundamental premise of otolith microchemistry is that the otolith is metabolically inert once it is formed. Unlike bone or scales, the calcium carbonate and trace elements deposited in the otolith rings are not reabsorbed or reworked by the fish's body. This means the otolith acts as a permanent and chronological chemical archive, preserving a record of the environments inhabited by the fish.

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provides a standard measure of the average maximum size for the population, which is essential for stock assessment models.

112. (C) $S = e^{\{-Z\}}$
The relationship between the survival rate and the instantaneous total mortality rate is described by an exponential decay function. The survival rate, which is the proportion of a population that remains alive at the end of a specific time period, is equal to the constant e raised to the power of the negative total mortality rate. This fundamental equation is used to predict population decline.

113. (D) High K and low L_∞
High natural mortality is a life history trait often associated with species that have a fast-paced lifecycle. Biologically, this typically correlates with high K values, indicating rapid growth, and relatively low maximum theoretical lengths. Such species often reach maturity early and have shorter lifespans, allowing them to replenish their populations quickly in response to high levels of predation or environmental stress.

114. (C) Constant across the years represented in the descending limb
Catch curve analysis is a method for estimating total mortality that relies on several key assumptions. One of the most important is that the recruitment of young fish into the fishery has remained relatively constant over the years represented by the individuals in the sample. If recruitment fluctuates significantly, the slope of the catch curve will be biased and provide an inaccurate estimate.

115. (B) Total recruitment significantly decreases
A highly overcompensatory stock-recruitment relationship, as modeled by the Ricker curve, predicts a dramatic decline in recruitment at very high levels of spawning biomass. This occurs because the negative impacts of overcrowding, such as increased cannibalism or disease transmission, outweigh any benefits of having more spawners. In such populations, the largest number of recruits is often produced at intermediate levels of spawning stock.

116. (C) Density-dependent population regulation
The concept of carrying capacity is fundamentally linked to the processes of density-dependent regulation within a population. As a fish population grows and approaches its environmental limit, competition for finite resources like food and habitat intensifies. This competition leads to a natural decrease in growth and recruitment or an increase in mortality, which eventually stabilizes the population size at its carrying capacity.

117. (A) Toward a larger length
Increasing the mesh size of a trawl net is a management action intended to improve the selectivity of the gear. This change shifts the L-fifty value, which is the length at which fifty percent of the fish are retained, toward a larger size. By allowing smaller individuals to escape, this measure helps protect juvenile fish and ensures that more individuals survive to reach maturity.

118. (A) Time lags between changes in effort and population response
A major weakness of simple surplus production models that assume equilibrium is their failure to account for time lags. In reality, a fish population does not respond instantly to changes in fishing effort; it takes time for recruitment and growth processes to adjust to new mortality levels. Ignoring these delays can lead to inaccurate predictions and potentially result in overfishing during periods of rapid change.

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119. (C) Yield per recruit reaches its absolute peak
In yield-per-recruit analysis, F-max is the specific level of fishing mortality that produces the absolute maximum yield from each recruit entering the fishery. While this point represents the theoretical peak of the production curve, it is often considered a risky management target because it does not account for the impact on the spawning stock or the risk of recruitment overfishing.

120. (C) I, III and IV
Pope's cohort analysis is a simplified mathematical approximation of virtual population analysis. It requires an estimate of the natural mortality rate and operates on the specific assumption that the entire annual catch occurs as a single pulse in the middle of the year. This method is widely used because it is much easier to calculate than exact VPA while still providing reliable results.

of fish, specifically the larval and juvenile periods. During these stages, individuals are often concentrated in specific nursery habitats where competition for food and space is intense. This competition, along with density-dependent predation and disease, acts as a primary regulatory mechanism that determines the eventual number of recruits entering the adult population.

140. (A) III, I, II, IV
A standard virtual population analysis begins with the compilation of a catch-at-age matrix. Next, an initial estimate for terminal fishing mortality is provided for the oldest age classes. The model then proceeds to calculate the number of survivors backward through time. Finally, the terminal mortality values are calibrated using independent tuning indices, such as survey data, to ensure the most accurate reconstruction.

141. (B) Gear selectivity
The length at fifty percent capture is a fundamental measure used to describe the selectivity of a particular fishing gear. It identifies the specific size at which a fish has an equal probability of being retained or escaping after encountering the gear. This parameter is essential for designing management regulations, such as mesh size limits, that aim to protect smaller individuals while allowing harvest.

142. (A) Biological overfishing and declining yields
If the level of fishing effort consistently exceeds the level required for maximum sustainable yield, the fishery will enter a state of biological overfishing. This occurs because the harvest rate is higher than the population's ability to replenish itself through growth and recruitment. As a result, the total biomass of the stock will decrease over time, eventually leading to a sustained decline in total yields.

143. (A) Constant and independent of spawning stock biomass
Yield-per-recruit models simplify the assessment of fishing impacts by focusing on the growth and mortality of a single cohort. A key assumption of these models is that the recruitment level remains constant and is completely independent of the size of the spawning stock biomass. While this allows for clear analysis of individual growth, it means the model cannot predict potential recruitment collapse from overfishing.

144. (C) In the oldest age class or the most recent year
In virtual population analysis, terminal fishing mortality refers to the mortality rate assigned to the final data points in the catch-at-age matrix. This includes both the oldest age classes across all years and all age classes in the most recent year of the study. Because VPA calculates population sizes backward, this terminal value is the essential starting point for all subsequent estimations.

145. (D) Total revenue exceeds total cost by the largest margin
Maximum Economic Yield is the level of fishing that maximizes the total economic rent, which is the difference between the total revenue generated and the total cost of fishing. At this point, the profitability of the fishery is at its absolute peak. Because fishing costs increase with effort, the level of effort required to achieve this economic optimum is always lower than that for MSY.

146. (A) A conservative target reference point
F-zero-point-one is widely recognized as a conservative and safe target reference point in fisheries management. It is defined as the level of fishing mortality where the marginal increase in yield per recruit is only ten percent of what it was at the origin. This target provides a significant buffer against uncertainty and the risk of overfishing, offering greater protection to the spawning stock.

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147. (A) Increased predation mortality on forage fish
Ecosystem models reveal that the populations of different species are closely linked through predator-prey relationships. If fishing pressure on an apex predator is reduced, its population will typically increase. This larger predator population will then exert higher predation pressure on its prey, such as forage fish, leading to an increase in their natural mortality. This illustrates the importance of multispecies management approaches.

148. (D) Thermodynamically impossible and unbalanced
In an ECOPATH model, the ecotrophic efficiency must be between zero and one. A value greater than one implies that more biomass is being consumed or exported than is actually being produced by that functional group. Such a result

130. (A) I, II, III
Genetic markers differ in their rates of molecular evolution, which determines their suitability for different types of studies. Allozymes generally have the lowest mutation rates, making them useful for studying broad population differences. Mitochondrial DNA has a higher mutation rate, while microsatellites exhibit the highest rates of all. This hierarchy allows researchers to choose the marker that provides the appropriate level of resolution.

131. (B) Fish market landing statistics
Fish market landing statistics are a primary source of fishery-dependent data. This information is collected directly from commercial fishing operations, reflecting the species, quantities, and sizes of fish that are actually harvested and brought to shore. While this data is essential for monitoring the fishery, it is subject to biases from fisher behavior and market demands, unlike scientific survey data.

132. (B) Condition factor representing fish plumpness
In the length-weight relationship equation, the parameter 'a' is a scaling coefficient that reflects the overall body condition or "plumpness" of the fish. This value can vary significantly based on factors such as food availability, reproductive state, and environmental conditions. Monitoring changes in 'a' over time or between seasons provides researchers with a simple way to assess the physiological well-being of a population.

133. (A) Larval and juvenile fishes
The analysis of daily growth increments on otoliths is an exceptionally powerful tool for studying the early life history of fish. Because these micro-increments are deposited every twenty-four hours, they allow researchers to determine the precise age of larval and juvenile individuals in days. This high-resolution data is essential for understanding the factors that influence survival and growth during these critical development stages.

134. (A) Growth rate in length decreases linearly as length approaches L∞
The von Bertalanffy growth function is defined by the mathematical property that the rate of growth in length is highest in young fish and gradually slows down over time. Specifically, the growth rate decreases linearly as the fish's current length approaches its maximum theoretical size. This relationship results in a curve that asymptotically levels off, accurately representing the growth patterns observed in many species.

135. (A) Instantaneous rate at which individuals are removed from the population
Total mortality is biologically described as the instantaneous rate at which individuals disappear from a population due to all possible causes. It is a continuous rate that accounts for both natural deaths, such as predation and disease, and deaths caused by fishing. This parameter is fundamental to understanding the dynamics of a stock and predicting its future size under various levels of harvest.

136. (A) M is difficult to estimate directly from standard fishery data
Natural mortality is one of the most challenging parameters to measure directly because deaths from predation or disease are rarely observed in the wild. Consequently, fisheries scientists often rely on empirical equations to estimate this value. These formulas use more easily obtainable data, such as growth parameters and environmental temperature, to provide a reliable estimate for use in stock assessment models.

137. (A) $-Z$
In a linearized catch curve, the natural logarithm of the number of individuals in each age class is plotted against their age. For the part of the population that is fully vulnerable to the fishing gear, the relationship is typically linear and declining. The negative of the slope of this descending line provides a direct estimate of the instantaneous total mortality rate.

138. (A) Approaches an asymptotic limit as stock size increases
The Beverton-Holt stock-recruitment model predicts that the number of recruits will increase with the size of the spawning stock but will eventually reach a maximum level. As the stock continues to grow, the recruitment rate slows down and approaches an asymptote. This behavior reflects density-dependent survival during early life stages, where limited resources or habitat space constrain the total number of survivors.

139. (A) Early larval and juvenile stages
Density-dependent natural mortality exerts its strongest influence during the early life stages

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157. (A) Vessel horsepower or gear size
To derive an accurate index of abundance from commercial catch data, it is necessary to standardize the effort using statistical techniques such as Generalized Linear Models. Common variables used in this process include vessel characteristics like horsepower and gear specifications like net size. By accounting for these factors, researchers can isolate the true trend in fish density from changes in fishing power and technology.

158. (B) Becomes relatively plumper or deeper
A length-weight exponent value greater than three indicates positive allometric growth. This means that as the fish grows in length, its weight increases at a faster rate than would be expected under isometric conditions. As a result, the fish's body shape changes over time, becoming relatively plumper, deeper, or more spherical. This is a common pattern for many species as they transition from juvenile to adult stages.

159. (A) Seasonal variations in growth rates
Annual growth rings on fish scales, known as annuli, are formed primarily due to predictable seasonal changes in growth. In many environments, growth slows down during periods of colder temperatures or reduced food availability, causing the circular ridges on the scale to become more closely spaced. When rapid growth resumes, a clear boundary is formed. These visible patterns allow researchers to estimate the age and growth history of the fish.

160. (A) P-2, Q-3, R-4, S-1
Different software tools are designed for specific types of fishery analysis. FiSAT II is the classic package for length-frequency assessment, while ECOPATH is the standard for mass-balance ecosystem modeling. TropFishR is a modern R-based tool that provides advanced length-based analysis within a reproducible workflow. Finally, Catch-MSY is a specialized method used to estimate maximum sustainable yield in situations where only historical catch data is available.

161. (A) Surface area, and catabolism with weight (volume)
The von Bertalanffy growth model is based on a fundamental physiological assumption about the balance of metabolism. It assumes that anabolism, the process of building tissue, is proportional to the surface area of the fish, specifically the respiratory surfaces. Conversely, catabolism, the process of breaking down tissue, is assumed to be proportional to the total weight or volume. The difference between these two rates determines the overall growth of the fish.

162. (A) Instantaneous rate of death
Natural mortality is mathematically defined as an instantaneous rate representing the constant probability of death from all non-fishing causes. This includes factors such as predation, disease, environmental stress, and senescence. In fishery models, it is treated as a continuous exponential rate that describes how a population would decline over time if no fishing were occurring. It is a fundamental parameter for assessing the impact of harvest on a stock.

163. (A) Hoenig's formula
Hoenig's empirical equation is a widely used method for estimating natural mortality that relies exclusively on the maximum observed age of a species. The formula is based on the biological principle that natural mortality and longevity are inversely related. By analyzing data from hundreds of species, Hoenig established a robust relationship that allows researchers to estimate mortality even when more complex data is unavailable.

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164. (A) High environmentally-driven stochasticity in survival of early life stages
Determining a clear relationship between the size of a spawning stock and the number of recruits is notoriously difficult in fisheries science. This challenge is primarily due to the high level of environmental stochasticity that affects the survival of eggs and larvae. Factors such as water temperature, currents, and food availability can cause recruitment to vary by orders of magnitude from year to year, masking any underlying stock-recruitment signal.

165. (A) Salinity shock from sudden freshwater influx
Density-independent mortality is caused by external factors that affect a population regardless of its density. A salinity shock, occurring from a sudden and massive influx of freshwater after a storm, is a clear example. Such events can cause significant mortality across all individuals in an area, regardless of how many fish are present. Unlike competition for food,

basic life-history parameters. This eliminates the need for absolute abundance estimates, total catch volumes, or precise effort data, which are often difficult or impossible to obtain in many artisanal and tropical fisheries.

200. (C) Both A and R are true and R is the correct explanation of A.
The ELEFAN routine is a cornerstone of length-based stock assessment. The assertion is true because the accuracy of the method depends entirely on the clear identification of modal peaks that represent distinct cohorts. The reason correctly explains this sensitivity by noting that the algorithm uses the R-n goodness-of-fit score to maximize the mathematical alignment between the fitted von Bertalanffy growth curve and these structural peaks.

201. (A) Domestic or national stock
A domestic or national stock is defined as a fish population that spends its entire lifecycle within the Exclusive Economic Zone of a single nation. Because these stocks do not migrate into the waters of other countries or the high seas, they are under the sole jurisdiction and management of that one state. This simplifies the assessment and regulatory process compared to straddling or transboundary stocks.

202. (A) Complete reproductive isolation and homogeneous population parameters
The concept of a unit stock is a fundamental assumption in most fishery models. It presumes that the group of fish being studied is a discrete entity with complete reproductive isolation from other groups of the same species. Furthermore, it assumes that the population has homogeneous parameters for vital processes such as growth, mortality, and recruitment, allowing for a single, consistent assessment within its geographic range.

203. (A) Higher K, lower L_∞
Tropical fish species typically exhibit growth patterns that are distinct from their temperate counterparts. Due to higher ambient water temperatures, they generally have higher curvature coefficients, meaning they reach their maximum size much more quickly. However, they also tend to have lower maximum theoretical lengths and shorter lifespans. This rapid lifecycle means that tropical stocks often have high turnover rates and a different response to fishing pressure.

204. (A) Continuous measurements of body parts
Morphometric characteristics are distinguished from meristic ones by the nature of the data they provide. Morphometrics involve continuous measurements of various body parts, such as head length, body depth, or fin length. These measurements describe the overall shape and proportions of the fish. Unlike meristic counts, morphometric data can vary based on individual growth, environmental conditions, and the specific methods used for preservation.

205. (A) Contamination during handling and sample preparation
Otolith microchemistry is an extremely sensitive technique that can be compromised by external factors. The most significant risk is contamination during the processes of handling and sample preparation. Because trace elements are present in very low concentrations, even small amounts of dust or chemical residue from tools can lead to inaccurate results. Maintaining strict clean-room protocols is essential for ensuring the reliability of chemical signatures.

206. (A) Nuclear microsatellite analysis
Nuclear microsatellite analysis is the most effective genetic technique for identifying recent hybridization between distinct fish stocks. Because microsatellites are biparentally inherited and highly polymorphic, they provide detailed information about the genetic contribution of both parents. This allows researchers to detect the presence of alleles from two different stocks within a single individual, providing clear evidence of interbreeding and the extent of hybridization in the population.

207. (A) Randomly distributes its effort across the entire species range
A fishery-dependent index of abundance is most reliable when the behavior of the fishing fleet mimics a random sampling design. If the fleet distributes its effort randomly across the entire geographic range of the species, the catch rate is more likely to reflect the true density of the population. However, in most commercial fisheries, fleets target high-density areas, which can introduce significant bias into the index.

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Length-based spawning potential ratio is a specialized tool for assessing stocks when only limited data is available. It estimates the spawning potential ratio directly from the size composition of the catch. This process requires knowledge of two key life-history ratios: the ratio of natural mortality to the growth coefficient and the length at maturity. This method allows for a robust evaluation of stock health without requiring absolute abundance or catch data.

175. (A) It incorporates advanced bootstrapped confidence intervals for growth parameters
The TropFishR package offers several modern advantages over the older FiSAT II software. One unique feature is its ability to perform advanced bootstrapping techniques to generate confidence intervals for growth parameters. This provides a more rigorous statistical evaluation of the uncertainty in the assessment. Additionally, being R-based, it allows for a more transparent, reproducible, and customizable workflow for fisheries researchers and managers.

176. (A) Straddling stock
Straddling stocks are fish populations that move between the Exclusive Economic Zone of a nation and the adjacent international high seas. Because these stocks inhabit both national and international waters, their assessment and management are particularly complex. They require international cooperation through specialized organizations to ensure that the total harvest, occurring across different legal jurisdictions, does not exceed sustainable levels and lead to the collapse of the stock.

177. (A) The lack of discrete age classes due to continuous spawning
A fundamental biological challenge in tropical fisheries is the absence of discrete age classes. Because many tropical species spawn throughout the year, there is a continuous influx of recruits, which leads to heavily overlapping cohorts. This lack of distinct peaks in size data makes it extremely difficult to apply standard age-based models or even simple length-frequency analysis to estimate critical parameters like growth and mortality.

178. (A) Are fixed early in development and remain constant
Meristic characters are highly valued in fish population studies because of their stability. These countable traits, such as the number of fin rays or vertebrae, are typically fixed during the early embryonic or larval stages of development. Once set, they do not change as the fish grows or in response to short-term environmental shifts. This permanence makes them excellent tools for distinguishing between genetically distinct stocks or different species.

179. (A) The ontogenetic life history and environmental migrations
Profiling the chemical composition of an otolith from its core to its edge provides a chronological record of a fish's entire life. This transect reveals the ontogenetic history, showing how the fish's environment and physiology changed from its larval stage to adulthood. Specifically, it can detect environmental migrations between different water masses, offering detailed insights into the migratory patterns and habitat use of individual fish over time.

180. (A) I only
Genetic markers have specific characteristics that determine their utility. Allozymes are variants of enzymes and their study involves protein electrophoresis, not direct DNA sequencing. In contrast, mitochondrial DNA is known for its maternal inheritance, while microsatellites are valued for their high mutation rates. SNPs, or single nucleotide polymorphisms, represent variations at a single base pair. Therefore, the description of allozymes is the only incorrect combination.

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181. (A) Hyperstability, where fleets target dense aggregations
Fishery-dependent catch-per-unit-effort can be a misleading indicator of abundance due to a phenomenon called hyperstability. This occurs when fishers use advanced technology to target specific areas where fish remain concentrated even as the total population declines. As a result, the catch rate may stay high and mask a serious stock collapse, giving a false impression of stability until the entire population is nearly exhausted.

182. (A) Post-spawning weight loss or severe starvation
A rapid decrease in a fish's condition factor over a short period is a clear indicator of physiological stress. This decline typically signifies either significant weight loss after a major spawning

event or a period of severe starvation due to a lack of food. Monitoring these changes helps researchers understand the seasonal energy cycles and the overall health and reproductive success of a fish population.

183. (A) Mark-recapture with chemical tagging (e.g., oxytetracycline)
The most rigorous way to validate age estimates from calcified structures is through mark-recapture experiments combined with chemical tagging. Substances like oxytetracycline leave a permanent fluorescent mark on the growing bone or otolith at the time of injection. When the fish is recaptured and the hard part is examined, the number of rings formed after the mark can be counted, providing a direct confirmation of the aging method's accuracy.

184. (A) Logarithmic differences of frequencies to identify normal distributions
Bhattacharya's method is a statistical routine that uses length-frequency data to identify distinct age groups within a population. It operates by plotting the logarithmic differences of the frequencies against length. This transformation turns a normal distribution into a straight line, making it much easier to identify and separate overlapping cohorts. This process is essential for estimating the mean length and abundance of each age class in the sample.

185. (A) Positive
In the von Bertalanffy growth function, the parameter t-zero is a theoretical value representing the age at which the fish would have zero length. If t-zero is mathematically fitted as a negative number, it implies that at age zero, the theoretical length of the fish is already a positive value. This mathematical adjustment is often necessary to better fit the growth data of young fish that may grow very rapidly.

186. (A) Catchability (q) and Fishing Effort (f)
The instantaneous rate of fishing mortality is a fundamental parameter that describes the intensity of harvesting. It is mathematically defined as the product of two variables: catchability and fishing effort. Catchability represents the proportion of the stock that is caught by a single unit of effort, while fishing effort reflects the total amount of fishing activity. Together, they determine the impact of the fishery on the stock.

187. (A) Higher temperatures generally increase metabolic and mortality rates
Pauly's empirical formula for estimating natural mortality includes mean environmental temperature because of its profound effect on fish physiology. In warmer waters, fish generally exhibit higher metabolic rates, which are typically associated with faster growth and higher natural mortality. By incorporating temperature, the formula accounts for these broad ecological patterns, providing a more accurate estimate of mortality for species across different climatic zones and ocean basins.

188. (A) Violating the assumption of constant mortality due to small sample bias
In catch curve analysis, it is necessary to exclude the oldest age classes if they are poorly represented in the sample. Small sample sizes in these groups can lead to significant statistical bias and noise. Including them might violate the fundamental assumption of constant mortality, leading to an inaccurate estimate of the total mortality rate. Focusing on the well-represented age groups ensures a more robust and reliable assessment.

189. (A) Territoriality and a fixed number of safe refuge sites
The shape of a stock-recruitment curve is driven by specific biological mechanisms. For the Beverton-Holt model, a key mechanism is the existence of a limited number of safe refuge sites or territories in nursery habitats. As the number of larvae increases, these high-quality sites are quickly filled. Any additional individuals are forced into lower-quality habitats where they face much higher mortality, leading to the characteristic asymptotic recruitment.

190. (C) I, II and III
Carrying capacity is a fundamental ecological concept representing the maximum population size that can be sustained by a given environment. At this point, the population growth rate naturally becomes zero as recruitment and mortality balance out. While carrying capacity can fluctuate in response to environmental changes, it is a biological limit determined by habitat and resources, not by fishing effort or economic targets like MSY.

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191. (B) Bell-shaped (normal distribution)
The probability of capture for gear like gillnets is typically described by a bell-shaped or normal distribution curve. This is because gillnets are highly selective for a specific size range of fish. Individuals that are too small can swim through the mesh, while those that are too large cannot be effectively gilled. Consequently, the probability of capture is highest for fish of an optimal intermediate size.

192. (A) Zero asymptotically
The Fox surplus production model uses an exponential relationship to describe how yield responds to fishing pressure. According to this model, as fishing effort increases indefinitely, the sustainable yield does not drop to zero in a parabolic fashion like the Schaefer model. Instead, it approaches zero asymptotically. This implies that the stock is slightly more resilient at very high effort levels, although the actual catch would be extremely low.

193. (A) Fishing mortality and age at first capture
The primary output of the Beverton-Holt yield-per-recruit model is a graphical representation often called a yield-isopleth diagram. This contour plot illustrates how the yield per recruit varies as a function of two key management variables: the instantaneous fishing mortality rate and the age at which fish are first captured. These plots are essential for identifying the optimal management strategies to maximize harvest from a single cohort.

194. (A) Reconstructs historical population numbers by distinct age cohorts
A fundamental difference between virtual population analysis and surplus production models is the level of detail they provide. VPA is an age-structured method that reconstructs the historical numbers and fishing mortality for each distinct age cohort within a population. In contrast, surplus production models treat the entire stock as a single aggregate biomass, ignoring the underlying age and size structure and how it changes over time.

195. (A) It ignores environmental variability and potential recruitment failure
Managing a fishery strictly at the level of maximum sustainable yield is considered biologically risky. This approach assumes a stable environment and does not account for natural fluctuations in recruitment or environmental conditions. If a stock is harvested at MSY during a period of poor recruitment, it can easily lead to overexploitation and potential collapse. Modern management often sets harvest levels below MSY to provide a buffer.

196. (A) The population is driven to theoretical extinction
The limit reference point known as F-crash represents an extreme and dangerous level of fishing mortality. At this rate, the harvest is so intense that the spawning stock is depleted faster than it can replenish itself through recruitment. If maintained, this level of mortality will theoretically drive the population to extinction. Reaching F-crash signifies a catastrophic failure in management and a complete collapse of the fishery resource.

197. (A) Higher estimated natural mortality for younger age classes
Explicitly incorporating predation into stock assessments through multispecies VPA generally leads to higher estimates of natural mortality, particularly for younger age classes. Traditional single-species models often assume a constant, low natural mortality for all ages. However, MSVPA reveals that small, young fish are subject to intense predation, which significantly increases their true mortality rate. This detailed understanding is essential for managing forage fish and predator-prey complexes.

198. (A) Differential equations integrating growth, mortality, and consumption
ECOSIM is the time-dynamic component of the ECOPATH modeling suite. It uses a series of differential equations to simulate how the biomass of various functional groups changes over time. These equations integrate complex biological processes including individual growth, natural and fishing mortality, and consumption based on prey availability and predator demand. This dynamic approach allows researchers to explore the ecological impacts of different fishing scenarios and environmental changes.

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199. (A) Total catch volumes or absolute effort data
The Length-Based Spawning Potential Ratio methodology is a powerful tool for assessing data-poor fisheries. Its primary advantage is that it provides a robust estimate of stock status using only the size composition of the catch and some

234. (A) Minimal seasonal temperature variations prevent clear opaque/translucent zone formation
Age determination using otolith annuli is particularly difficult for tropical fish species. In many tropical regions, the lack of significant seasonal variation in water temperature means that the fish grow at a relatively constant rate throughout the year. As a result, the distinct opaque and translucent zones that form annual rings in temperate fish are often absent or poorly defined, making it challenging to estimate the age of these individuals.

235. (A) Fish cannot have negative age
The parameter t-zero in the von Bertalanffy growth function is a mathematical constant that often takes a negative value to allow the curve to better fit the observed data. Biologically, however, it has no real meaning because a fish cannot have a negative age. It simply represents a theoretical point in time when the fish would have had zero length if it had always followed the growth curve.

236. (A) Total deaths in the population caused by fishing
The exploitation rate is a critical indicator of the impact of harvesting on a fish population. It is mathematically defined as the ratio of instantaneous fishing mortality to the total instantaneous mortality. This value represents the fraction of all deaths in the population that are directly caused by fishing activities. A high exploitation rate suggests that harvesting is the dominant source of mortality for the stock.

237. (A) The regression intercept method
The regression intercept method is a technique for estimating natural mortality by analyzing the relationship between total mortality and fishing effort over several years. By plotting Z against effort, a linear regression can be performed. The slope of the line represents the catchability coefficient, while the y-intercept, where fishing effort is zero, provides an estimate of the instantaneous natural mortality rate for the population.

238. (A) True age structure of the population above the age of full selection
Catch curve analysis is based on the fundamental assumption that the sample of fish being studied is representative of the entire population's age structure. Specifically, for the age classes that are fully recruited and vulnerable to the fishing gear, the relative abundance of each age in the catch is assumed to reflect their true numbers in the water. This allows researchers to estimate mortality from the declining abundance of older fish.

239. (A) Cannibalism or the spread of disease proportional to initial cohort density
The Ricker stock-recruitment model assumes that the primary cause of density-dependent mortality is overcompensatory in nature. This means that at very high densities of spawners or larvae, mortality increases dramatically due to factors such as cannibalism by adults or the rapid spread of disease within crowded nursery areas. These processes lead to a decline in total recruitment when the spawning stock is excessively large, creating a characteristic dome-shaped relationship.

240. (A) The population density or size
Density-independent population regulation occurs when the proportion of individuals dying is caused by factors that do not change with the population size. These factors are typically environmental, such as sudden changes in water temperature, salinity, or severe weather events. In these cases, the impact of the stressor is the same regardless of whether the population is small and scattered or large and densely packed.

241. (A) Making the selection curve steeper (sharper selection)
Switching from traditional diamond mesh to square mesh in a trawl net typically improves the selectivity of the gear. Because square meshes remain open under tension while diamond meshes tend to close, smaller fish can escape more easily. This results in a steeper selection ogive, meaning the transition from zero to full retention occurs over a narrower range of fish lengths, providing a sharper and more precise selection.

242. (A) Increase toward BMSY
In the Schaefer surplus production model, the population biomass naturally tends toward the level that produces maximum sustainable yield if the fishing effort is held constant at the corresponding E-MSY level. If the current biomass is below this optimum level, the reduced harvest will allow the population to grow. Over time, the biomass will increase until it reaches

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208. (A) Logarithmic transformation
The relationship between the length and weight of a fish is typically described by a power function. To estimate the parameters of this relationship, researchers usually apply a logarithmic transformation to both the length and weight data. This process linearizes the relationship, allowing for the use of simple linear regression to calculate the values of the scaling coefficient and the growth exponent, which are essential for stock assessment.

209. (A) Overestimation of age
The presence of false annuli on fish scales is a common source of error in age determination. These marks can be caused by various physiological stressors, such as injury, disease, or temporary food shortages, rather than true annual growth cycles. If these false marks are incorrectly identified as yearly rings, it will lead to an overestimation of the fish's age and an underestimation of its true growth rate.

210. (A) P-2, Q-1, R-4, S-3
Fisheries science uses standardized symbols to represent key biological parameters. Asymptotic length is denoted by L-infinity, while natural mortality is represented by M. The exploitation rate is designated by E, and the curvature parameter, which describes the rate at which length approaches the asymptote, is symbolized by K. Understanding these symbols is fundamental for interpreting and applying stock assessment models.

211. (A) Competing, simultaneous continuous exponential rates
The formula for total mortality assumes that individuals are removed from a population through two distinct but simultaneous processes. Natural mortality and fishing mortality are treated as continuous exponential rates that compete for the same pool of individuals. This means that a fish that dies from predation is no longer available to be caught by a fisher. These simultaneous rates combine to determine the overall rate of population decline.

212. (A) A lower natural mortality (M)
Hoenig's equation is based on the biological principle that natural mortality and longevity are inversely proportional. Therefore, a population that has a higher maximum observed age among its individuals is predicted to have a lower instantaneous rate of natural mortality. This makes intuitive sense, as for a fish to reach a very old age, its probability of dying each year must be relatively low.

213. (A) Time or relative age
In the construction of a standard linearized catch curve, the horizontal x-axis represents the time or the relative age of the fish in each class. The vertical y-axis represents the natural logarithm of the number of individuals. This specific arrangement allows the negative slope of the resulting linear relationship for the fully recruited age classes to be directly interpreted as the instantaneous total mortality rate.

214. (A) Stabilizing force preventing unlimited population growth
Density-dependent effects serve as a critical stabilizing mechanism within biological populations. These processes, such as competition for food and space, increase in intensity as the population density rises. By naturally reducing recruitment and growth or increasing mortality, they prevent the population from growing indefinitely beyond the environment's carrying capacity, ensuring that the stock fluctuates around a sustainable long-term equilibrium level.

215. (A) Increases to a peak then declines at high stock densities
The Ricker stock-recruitment curve is uniquely characterized by its dome shape. It predicts that recruitment will initially increase as the number of spawners grows, reaching a maximum peak at intermediate stock levels. However, at even higher densities, recruitment begins to decline due to overcompensatory factors such as cannibalism or disease. This model suggests that excessively large spawning stocks can actually be less productive for the fishery.

216. (A) The selection range (e.g., $L_{\{75\}} - L_{\{25\}}$)
The selection range is a key parameter that describes the sharpness or steepness of a gear selection ogive. It is calculated as the difference between the lengths at which seventy-five percent and twenty-five percent of the fish are retained. A narrow selection range indicates a very sharp, precise selection, where the probability of capture increases rapidly over a small change in fish size.

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217. (A) $Y = aE + bE^2$
The basic equation for equilibrium yield in the Schaefer model is a quadratic function of fishing effort. Based on the logistic growth equation, it predicts that sustainable yield will follow a symmetrical parabolic curve. Yield increases linearly with effort at first, but the rate of increase slows down due to the squared term until it reaches a maximum. Beyond this peak, further increases in effort cause the yield to decline.

218. (A) Very high natural mortality relative to growth rate
Yield-per-recruit curves do not always show a distinct maximum. In species that have a very high rate of natural mortality relative to their growth rate, the curve may continuously increase or level off without ever peaking. For these stocks, the individuals are dying of natural causes so quickly that increasing fishing pressure always results in more yield being harvested before the fish die naturally.

219. (A) Backward-calculating deterministic accounting model of past population states
Virtual population analysis is fundamentally a deterministic accounting method used to reconstruct historical population levels. By using data on the total catch from each age cohort and an assumed natural mortality rate, the model works backward in time to estimate the number of fish that must have been alive at each previous age. This allows researchers to track how specific cohorts were depleted by fishing over their entire lifespan.

220. (C) Both A and R are true and R is the correct explanation of A.
Maximum Economic Yield represents the level of fishing that produces the largest profit. The assertion is true because MEY always occurs at a lower effort level than MSY. The reason correctly explains this by noting that as effort increases toward the biological maximum, the marginal cost of additional fishing activity eventually exceeds the marginal revenue, meaning the economic optimum is reached well before the maximum sustainable catch.

221. (A) The relationship between spawning stock size and subsequent recruitment
Yield-per-recruit analysis is a powerful tool for understanding how to maximize the harvest from a single group of fish, but it has a significant limitation. It explicitly ignores the stock-recruitment relationship, assuming that recruitment remains constant regardless of the size of the spawning stock. This means that biological reference points like F-max do not account for the risk of depleting the parent stock to unsustainable levels.

222. (A) The interaction frequency and conversion efficiencies between the two species
The Lotka-Volterra equations model the dynamics of predator and prey populations based on their direct interactions. The change in each population is a function of how often the two species encounter each other and the efficiency with which the predator converts consumed prey into new offspring. These parameters drive the characteristic oscillating cycles of abundance that are the hallmark of these classical ecological models.

223. (A) Proportions (percentages) of prey groups in the diet of predators
In the construction of an ECOPATH model, data on trophic interactions is a critical input. This information is typically entered as the proportion or percentage of various prey groups in the overall diet of each predator group. These diet compositions allow the model to estimate the flow of energy and biomass through the food web, ensuring that the consumption demands of predators are balanced by the production of their prey.

224. (A) Intrinsic rate of population increase (r)
Catch-only models like Catch-MSY are designed to estimate the status of fish stocks when only historical catch records are available. These models operate by using mathematical priors for the stock's resilience, specifically its intrinsic rate of population increase. By combining these priors with the catch data, the model can simulate a range of possible population trajectories and identify those that are most biologically plausible for the stock.

225. (A) Length-frequency distributions
The Powell-Wetherall plot is a graphical method used in fisheries science to estimate the maximum theoretical length and the ratio of total mortality to the growth coefficient. It is specifically designed to use data derived exclusively from length-frequency distributions. By plotting

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the mean length of all fish above a certain size against that size, the method provides a reliable way to estimate vital parameters from simple size data.

226. (A) Slight genetic variations, provided population dynamics parameters are homogeneous
A unit stock is an operational concept used for management and does not always perfectly align with a strictly defined genetic population. For the purposes of stock assessment, a unit stock may contain some minor genetic variations between individuals. The most important requirement is that the population dynamics parameters, such as growth, mortality, and recruitment, are sufficiently homogeneous across the entire group to be managed as a single unit.

227. (A) The necessity of multi-national compliance and shared data
Management of highly migratory species like tunas is inherently complex because these fish travel across vast ocean areas and many different national jurisdictions. Effective conservation requires the cooperation of all nations involved in the fishery to share accurate catch data and comply with agreed-upon harvest limits. Without this multi-national coordination, it is impossible to assess the status of the entire stock or to prevent overexploitation in international waters.

228. (A) Identifying individual species in catch records is often difficult or aggregated
A major challenge in assessing tropical multi-species fisheries is the way data is recorded. Because these fisheries harvest hundreds of different species using various gears, catch records are often highly aggregated into broad categories. This makes it difficult to identify the trends for individual species, which is essential for standard assessment models. Accurate species-level data is often missing, complicating the assessment of these highly diverse and complex systems.

229. (A) Ensure uniform coverage of the body shape in two dimensions
Truss network analysis is a superior morphometric method because it provides a comprehensive and uniform representation of a fish's body shape in two dimensions. By using a systematic grid of measurements between homologous landmarks, it captures information about body depth and proportions that traditional linear measurements often miss. This more detailed description of the morphology allows for better discrimination between different fish stocks and populations.

230. (B) P-3, Q-1, R-2, S-4
Stock assessment models are built on different mathematical foundations. Virtual population analysis uses the cohort survival equation to reconstruct history. The Schaefer model is based on the logistic population growth equation. ECOPATH utilizes a set of mass-balance linear equations to model ecosystem energy flows. Finally, the yield-per-recruit model uses continuous growth and mortality integrals to predict the harvest from a single group of recruits over time.

231. (A) Divergent frequencies of distinct protein variants
Identifying mixed stocks through allozyme electrophoresis relies on the biological principle that isolated breeding populations will develop genetic differences. This technique measures the frequencies of different protein variants, or allozymes, within a sample of fish. By detecting significant differences in these allele frequencies between groups, researchers can confirm the presence of distinct, genetically isolated stocks even if they are harvested together in the same fishery.

232. (A) Is the raw unadjusted ratio of catch to effort
Nominal catch per unit effort is the simplest measure of a fishery's productivity, calculated as the raw ratio of the total catch to the total fishing effort. However, this value is often biased by changes in gear efficiency, technology, and environmental conditions. Standardized CPUE, in contrast, uses statistical models to account for these external factors, providing a more accurate index of the true underlying fish abundance.

233. (A) Season, sexual maturity, and food availability
The condition factor of a fish stock is a dynamic index that reflects the physiological well-being of the population. It frequently varies in response to seasonal changes in the environment, the reproductive cycle of the fish as they reach sexual maturity, and the availability of food resources. Monitoring these fluctuations provides researchers with valuable insights into the health, nutritional status, and reproductive potential of the fish population over time.

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the severity of this environmental stressor is not linked to population size.

166. (A) Smaller fish being trapped in the codend by larger fish
The selection curve for a trawl net is often asymmetrical and skewed toward larger sizes because of various operational factors. One common cause is the "clogging effect," where larger fish already caught in the codend physically block the mesh openings. This prevents smaller individuals from escaping, even if they would otherwise fit through the mesh. This interaction complicates the relationship between mesh size and the probability of retention.

167. (A) 50% of carrying capacity
The Schaefer surplus production model is based on the logistic growth equation, which assumes a symmetrical relationship between population size and productivity. According to this model, the highest rate of surplus production, and thus the maximum sustainable yield, occurs exactly when the population biomass is at fifty percent of its environmental carrying capacity. This symmetrical property simplifies the calculation of management reference points but may not apply to all species.

168. (A) Age- or size-specific fishing mortality and weights
The Thompson and Bell model is an analytical approach that requires detailed input data to provide accurate predictions. Specifically, it depends on knowing the age- or size-specific rates of fishing mortality and the corresponding average weights of the fish. By using these detailed arrays, the model can simulate how changes in fishing pressure and gear selectivity will affect the total yield and the economic performance of the fishery.

169. (A) Less than 1.2 and catch is concentrated mid-year
Pope's cohort analysis is a simplified method that provides a very close approximation of virtual population analysis under certain conditions. It is most accurate when the instantaneous total mortality rate is less than one-point-two. Additionally, its assumption that the entire catch is taken mid-year becomes less problematic when fishing activity is actually concentrated in that period. Within these limits, the mathematical error introduced by the simplification is considered negligible.

170. (D) I, II and III
Determining the Optimum Yield for a fishery is a multi-dimensional process that goes beyond simple biology. It requires the integration of three primary factors: the biological limits of the stock as defined by MSY, the economic profitability of the fishing industry, and various social or ecological objectives. This holistic approach ensures that management decisions reflect the complex goals of society while maintaining the long-term sustainability of the marine resource.

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171. (A) Recruitment is severely compromised (recruitment overfishing)
A limit reference point for spawning stock biomass represents a critical threshold that should not be crossed. If the biomass falls below this point, the stock is considered to be in a state of recruitment overfishing. At this level, the number of mature individuals is too low to ensure adequate recruitment for the future, posing a severe risk to the continued existence and recovery of the population.

172. (A) Predator stomach contents
Multispecies virtual population analysis is a data-intensive modeling approach that explicitly accounts for predator-prey interactions. The most critical data requirement for this model is extensive information on predator stomach contents. By analyzing what and how much predators eat, the model can internally calculate the predation mortality for various prey species, providing a more realistic and comprehensive assessment of total mortality within the ecosystem.

173. (A) The system is in steady state
The primary assumption of a mass-balance model like ECOPATH is that the ecosystem is in a steady state during the specific time period being modeled. This means that for each functional group, the total production is exactly balanced by the sum of consumption by predators, fishing harvest, and other forms of mortality or export. This assumption allows researchers to create a static snapshot of the energy and biomass flows.

174. (A) Size composition of the catch and life-history ratios ($\frac{M}{K}$, L_m)

the B-MSY level, where the surplus production is maximized.

243. (A) Age at first capture
The parameter t_c is a fundamental component of the Beverton-Holt yield-per-recruit model, representing the age at which fish first become vulnerable to the fishing gear. By adjusting this parameter through regulations like mesh size limits, managers can control the size of the fish being harvested. Finding the optimal age at first capture is essential for preventing growth overfishing and maximizing the long-term yield from each group of recruits.

244. (A) Initial guessed terminal F errors dissipate and estimates for younger ages become highly accurate
A unique and valuable property of virtual population analysis is that the backward calculations tend to converge over time. This means that even if the initial estimate for terminal fishing mortality is slightly inaccurate, the error becomes smaller as the model moves toward younger age classes. For cohorts that have been heavily fished, the estimates for their early years become highly robust and accurate, providing a reliable reconstruction of history.

245. (A) Lower than MSY to provide a buffer against uncertainty
An Optimum Yield policy is a precautionary approach to fisheries management. Because there is always uncertainty in biological assessments and environmental conditions, OY is typically set at a harvest level that is lower than the theoretical Maximum Sustainable Yield. This provides a safety buffer that reduces the risk of overfishing and stock collapse, while still providing stable economic and social benefits from the fishery.

246. (A) Exactly 10% of the slope at the origin
F-zero-point-one is a specific biological reference point derived from yield-per-recruit analysis. It is defined as the level of fishing mortality where the slope of the yield curve is exactly ten percent of the initial slope at the origin. This level is more conservative than F-max and is widely used as a target for sustainable management because it provides greater protection to the spawning stock while still allowing significant harvest.

247. (A) A variable residual mortality (M_1) and calculated predation mortality (M_2)
Multispecies virtual population analysis improves upon single-species models by providing a more realistic treatment of natural mortality. Instead of a constant rate, it uses two components: residual mortality, which covers deaths from non-trophic causes, and predation mortality, which is calculated internally based on the abundance and diet of predators. This allows the model to capture how mortality changes as predator and prey populations fluctuate within the ecosystem.

248. (A) External time-series drivers like fishing effort or environmental changes
In ECOSIM simulations, forcing functions are used to represent external factors that drive changes in the ecosystem over time. These can include historical time series of fishing effort for different fleets or environmental variables like sea surface temperature. By applying these functions to the model, researchers can explore how the ecosystem has responded to past pressures and predict how it might change under different future scenarios.

249. (A) It is highly sensitive to the assumption of a steady-state (equilibrium)
While the Length-Based Spawning Potential Ratio method is a powerful tool for data-limited fisheries, it has a significant limitation. The model relies heavily on the assumption that the stock is in a steady state, meaning that recruitment and fishing pressure have remained relatively stable. If the fishery is experiencing rapid changes or significant fluctuations, the results may be biased, potentially leading to inaccurate assessments of stock status and health.

250. (A) Proportion of available structural peaks passing through the fitted growth curve
The R_n score is the goodness-of-fit metric used by the ELEFAN algorithm to evaluate different von Bertalanffy growth curves. It mathematically represents the proportion of the modal peaks in the restructured length-frequency data that are correctly intersected by the growth curve. By maximizing this score, the algorithm identifies the parameters that best describe the growth of the various cohorts within the population, providing an objective way to estimate growth.

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251. (A) Localized extinction of the least productive sub-populations
Managing a complex of genetically isolated sub-populations as a single unit stock is a risky strategy. Even if the total harvest seems sustainable for the aggregate, it may exceed the productivity of the smaller or less productive sub-populations. Over time, this can lead to the localized extinction of these unique groups, reducing the overall genetic diversity and resilience of the species and potentially causing a permanent loss of productivity.

252. (A) Straddling and highly migratory fish stocks
The United Nations Fish Stocks Agreement was established to provide a specific legal framework for the conservation and management of straddling and highly migratory fish stocks. These populations are particularly vulnerable because they travel across the boundaries between national Exclusive Economic Zones and the international high seas. The agreement emphasizes the obligation of nations to cooperate and use the precautionary approach to ensure the long-term sustainability of these shared resources.

253. (A) Form a single, unimodal distribution lacking distinct cohort peaks
In many tropical fisheries, the combination of continuous year-round spawning and high growth rates makes it difficult to see distinct age groups in size data. Length-frequency histograms often appear as a single, large unimodal distribution where the different cohorts have completely blended together. Without clear and separate modal peaks to track over time, standard methods for estimating growth and mortality become much more difficult to apply accurately.

254. (A) Reduce dimensionality and identify the most significant shape variations
Principal Component Analysis is a multivariate statistical technique used to simplify the complex datasets produced by truss network studies. By analyzing the many different measurements taken across the fish body, PCA reduces the dimensionality of the data into a few principal components. This allows researchers to identify and visualize the most significant patterns of variation in body shape, providing a powerful way to distinguish between different stocks or populations.

255. (A) Estuarine and freshwater environments
The concentration of barium in fish otoliths is a useful environmental marker because it is typically found in much higher levels in freshwater and estuarine environments than in the open ocean. By analyzing the barium-to-calcium ratio along an otolith growth transect, researchers can identify when a fish moved into or out of these low-salinity habitats. This chemical signature is a key tool for studying the migratory history of diadromous species.

256. (A) Non-coding regions that accumulate mutations rapidly
Microsatellites are ideal genetic markers for distinguishing between closely related fish stocks. These regions of DNA are non-coding, meaning they do not affect the physical traits of the fish and are not subject to intense natural selection. As a result, they can accumulate mutations very rapidly, creating a high level of genetic variation. This rapid evolution allows researchers to detect even subtle genetic differences that indicate the presence of isolated populations.

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257. (A) Changes in gear efficiency and spatial targeting over time
Catch per unit effort from commercial fisheries is often a biased index of abundance because it is influenced by human behavior and technological progress. Over time, fishers adopt more efficient gear and better technology to find and catch fish more effectively. Furthermore, fleets tend to target areas where fish are most concentrated. These factors can keep catch rates high even as the overall population declines, a phenomenon known as hyperstability.

258. (A) Isometric ($b = 3$)
Fulton's condition factor is a widely used index for comparing the physiological state of fish. However, this comparison is only mathematically valid if the species exhibits isometric growth, where the length-weight exponent is exactly three. If a species grows allometrically, its body shape changes as it gets larger, and the condition factor will naturally increase or decrease with length, making it difficult to distinguish between true health and simple size effects.

259. (A) Compound microscopes or scanning electron microscopy (SEM)
Daily growth increments on otoliths are microscopic features that are far too small to be

seen with the naked eye. To count these rings and estimate the age of larval or juvenile fish, researchers must use high-power compound microscopes. In some cases, where the increments are exceptionally fine or closely spaced, scanning electron microscopy is required to provide the necessary resolution. This detailed work allows for the precise determination of age in days.

260. (A) Cut-off length (L')
The Powell-Wetherall method is a technique for estimating the maximum theoretical length from length-frequency data. It works by calculating the mean length of all fish that are larger than a specific cut-off length. By plotting this mean length against a series of increasing cut-off lengths, the relationship produces a straight line. The x-intercept of this line provides a direct estimate of the L-infinity parameter, which is essential for many growth models.

261. (A) How quickly the fish approaches its maximum size
In the von Bertalanffy growth function, the curvature parameter K is a measure of the fish's growth rate relative to its maximum possible size. A high K value indicates that the fish grows very quickly when young and reaches its asymptotic length at an early age. These species typically have fast lifecycles and shorter lifespans. Conversely, a low K value describes a species that grows slowly and takes many years to approach its maximum size.

262. (A) 0.75
The exploitation rate is calculated by dividing the fishing mortality by the total mortality, which is the sum of fishing and natural mortality. In this case, with a fishing mortality of zero-point-six and a natural mortality of zero-point-two, the total mortality is zero-point-eight. Dividing zero-point-six by zero-point-eight results in an exploitation rate of zero-point-seven-five, indicating that seventy-five percent of all deaths in the population are caused by fishing.

263. (A) L_∞, K, and temperature
Pauly's empirical equation for estimating natural mortality is a multiple regression model derived from data on over a hundred different fish stocks. It uses three primary independent variables: the maximum theoretical length, the curvature parameter from the growth function, and the mean annual temperature of the environment. This formula provides a practical way for scientists to estimate mortality for many species where direct measurements are impossible, based on broad ecological relationships.

264. (A) Incompletely recruited to the fishing gear
In a linearized catch curve, the ascending left limb represents the younger age groups in the population. The non-linear, convex shape of this limb indicates that these smaller fish are not yet fully vulnerable to the fishing gear. They may be small enough to escape through the mesh or inhabit different areas from the larger adults. Because they are only partially represented in the catch, they cannot be used to estimate mortality.

265. (A) The spawning stock is depleted to a level that severely impairs subsequent recruitment
Recruitment overfishing is one of the most serious threats to the long-term sustainability of a fishery. It occurs when the level of fishing pressure is so high that the total number of mature individuals, or the spawning stock biomass, is reduced to a point where it can no longer produce enough eggs and larvae to replenish the population. This leads to a sustained decline in recruitment and can eventually cause the stock to collapse.

266. (A) Density-dependent regulation
Density-dependent regulation is the fundamental biological process that prevents fish populations from growing indefinitely. As a population becomes larger and more crowded, competition for essential resources like food and suitable habitat increases. This competition naturally leads to a decrease in growth and recruitment rates and an increase in mortality. These feedback mechanisms act to stabilize the population at a level that the environment can support, known as the carrying capacity.

267. (A) Realize their major somatic growth potential
Growth overfishing occurs when fish are harvested at an average size that is smaller than the size that would maximize the yield per recruit. Mesh size regulations are implemented to prevent this by allowing smaller individuals to escape and continue growing. By ensuring that fish are not caught until they have reached a larger size, the fishery can harvest more total biomass from each individual that enters the population, maximizing the overall productivity.

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considered. This includes not just the fishers themselves, but also conservation groups, coastal communities, government agencies, and the seafood industry. By involving anyone who has an interest in or can influence the management of the fishery, the EAFM process aims to create more equitable, transparent, and sustainable management decisions.

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276. (A) ELEFAN
The ELEFAN algorithm is widely recognized as the foundational method for analyzing length-frequency data in tropical fisheries. Specifically developed for situations where age data is unavailable, it identifies and tracks the progression of modal peaks in size histograms to estimate growth parameters. Its relative simplicity and effectiveness have made it the most commonly used tool for stock assessment in many developing nations and data-poor regions around the world.

277. (A) A network of spatially separated populations interacting via larval dispersal or migration
In fisheries science, a metapopulation is a conceptual framework describing a group of spatially distinct populations that are linked by some level of movement. This connectivity often occurs through the dispersal of larvae on ocean currents or the migration of juvenile and adult fish between different areas. Understanding these links is essential for effective management, as the health of one local population can depend on the productivity and connectivity of others in the network.

278. (A) An Exclusive Economic Zone (EEZ) and the high seas
Straddling fish stocks are defined by their unique geographic distribution across political boundaries. These are populations that inhabit and migrate between the Exclusive Economic Zone of a coastal nation and the adjacent international waters of the high seas. Because they are harvested in both areas, their management is a shared responsibility that requires international cooperation and specialized agreements to ensure that the total harvest remains sustainable across different legal jurisdictions.

279. (A) Employ standard length-frequency sampling due to inadequate sample sizes per species
Tropical fisheries are often characterized by high biodiversity, containing hundreds of species, but with many species present in low individual numbers. This diversity makes it extremely difficult to conduct standard length-frequency analysis. For many species, it is nearly impossible to obtain the large and consistent sample sizes required to see clear modal peaks in the data. This challenge often forces researchers to aggregate species or use alternative, data-limited assessment methods.

280. (A) Are extremely difficult to count precisely on small specimens
While meristic characters are useful for distinguishing between different fish populations, they have practical limitations. In many species, especially during the larval or juvenile stages, these countable traits are extremely small and difficult to see. Obtaining precise counts of fin rays or scales often requires specialized equipment and significant time, which can be a major drawback in large-scale field studies where quick and reliable data collection is essential.

281. (A) The isotopic composition of the ambient water
The oxygen isotope signature preserved in fish otoliths is determined by two primary factors: the temperature of the surrounding water and its own isotopic composition. Because different water masses can have distinct isotopic profiles, this signature serves as a record of both the thermal environment and the specific water body inhabited by the fish. This allows researchers to reconstruct migration patterns and distinguish between fish that lived in different ocean regions or salinity levels.

282. (A) Fine-scale, relatively recent population structuring
Mitochondrial DNA is a highly valuable marker in fisheries genetics due to its high rate of molecular evolution. This rapid mutation rate allows for the detection of genetic differences between populations that have only recently diverged. As a result, mtDNA is particularly effective for resolving fine-scale population structuring and identifying distinct stocks within a species that may not be apparent using other, more slowly evolving genetic markers.

283. (A) The true underlying trend in stock abundance
When standardizing catch per unit effort using Generalized Linear Models, the primary goal is to isolate the "year" effect. This variable is intended to represent the true underlying trend in the abundance of the fish stock after all other influencing factors, such as changes in technology, vessel power, and spatial distribution, have been accounted for. The resulting standardized index provides a more accurate and reliable reflection of the stock's health and trajectory over time.

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stability.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2010
11. Which coefficient is calculated as the ratio of the underwater volume of a vessel to the volume of a rectangular block having the same overall length, breadth, and draft?
(A) Block coefficient
(B) Prismatic coefficient
(C) Midship section coefficient
(D) Waterplane area coefficient

2019
12. If a fishing vessel's metacentric height (GM) is negative, what is the immediate effect on the vessel?
(A) It will ride higher in the water.
(B) It will quickly snap back to the upright position.
(C) It will become loll and float at an angle.
(D) It will experience reduced frictional resistance.

2007
13. Which material is traditionally favored for small-scale boat building due to its natural buoyancy and ease of working, despite requiring intensive maintenance against rot?
(A) Aluminum
(B) Ferro-cement
(C) Fiberglass Reinforced Plastic
(D) Marine wood

2024
14. What is a primary disadvantage of using steel for constructing small fishing vessel hulls compared to FRP?
(A) Inherent risks related to high material flammability
(B) Inability to withstand high-energy hull impacts
(C) Ongoing needs for surface corrosion protection
(D) Lower weight profiles affecting overall stability

2021
15. The comparative advantage of aluminum over steel in boat building is best described by which statement?
(A) Heavier material profile used to increase stability
(B) Higher strength-to-weight ratio and resistance
(C) Simpler welding processes without using inert gases
(D) Superior insulation against extreme cold conditions

2025
16. Ferro-cement boat construction utilizes which combination of materials to achieve hull integrity?
(A) Standard wood planking layers coated in mortar
(B) Fiberglass resin cores injected with liquid cement
(C) Reinforced aluminum frames using concrete blocks
(D) Steel wire mesh armature and rich cement mortar

2006
17. Identify the INCORRECT pair regarding boat building materials and their typical properties.
(A) Wood - Isotropic material with uniform strength in all directions
(B) FRP - Non-magnetic and resistant to marine borers
(C) Steel - High tensile strength and prone to oxidation
(D) Aluminum - Lightweight and susceptible to galvanic corrosion

2002
18. Fiberglass Reinforced Plastic (FRP) is a composite material primarily consisting of which two functional components?
(A) A steel matrix and fiberglass reinforcement
(B) A cement matrix and plastic fiber reinforcement
(C) A polymer resin matrix and glass fiber reinforcement
(D) A wooden core and epoxy surface layer

2013
19. What is the main structural function of the gelcoat in FRP boat construction?
(A) Smooth, protective, and water-resistant finish
(B) Primary structural matrix for load-bearing use
(C) Prevention of internal cracking in glass fibers
(D) Thermal insulation layer for internal fish holds

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growth equation. A key characteristic of this model is its perfect symmetry, which dictates that the population's maximum productivity occurs exactly when its biomass is at fifty percent of its environmental carrying capacity. At this specific point, known as B-MSY, the stock's net growth is at its absolute peak, allowing for the largest possible sustainable harvest by the fishery.

293. (A) Age at first capture and corresponding fishing mortality
Yield-per-recruit models are essential management tools because they focus on two variables that can be directly controlled by regulations. These models identify the optimal age at first capture, which can be managed through mesh size limits, and the optimal level of fishing mortality, managed through effort controls or quotas. By finding the right combination of these two factors, managers can maximize the total biomass harvested from each individual entering the fishery.

294. (A) Increase significantly
Virtual population analysis is highly sensitive to the initial value of terminal fishing mortality. If a researcher replaces a high terminal F with a much lower one, the model's backward calculations will indicate that a larger initial population was needed to account for the observed catches. Consequently, the estimated historical biomass for all age cohorts will increase significantly. This illustrates why the calibration of terminal mortality is such a critical step in the assessment process.

295. (A) Higher than the biomass at MSY
Maximum Economic Yield is the harvest level that generates the greatest profit for the fishing industry. Because fishing costs increase as the population becomes smaller and harder to find, the economic optimum always occurs at a lower level of effort than the Maximum Sustainable Yield. This lower effort naturally results in a standing stock biomass that is higher than B-MSY, providing both greater economic returns and a larger biological safety buffer for the stock.

296. (A) Recruitment overfishing by severely depleting the spawning stock
F-max is a biological reference point representing the fishing mortality that maximizes the yield from each recruit. However, it is often criticized as a management target because it is frequently too high. Harvesting at this rate can severely deplete the total spawning stock biomass to a level where recruitment becomes impaired. This risk of recruitment overfishing is why many managers prefer more conservative reference points like F-zero-point-one, which offer better protection for the population's future.

297. (A) Decreases linearly with age as they outgrow predator gape sizes
In multispecies models like MSVPA, the estimated natural mortality for forage fish often shows a clear age-dependent trend. For species like sardines, mortality is typically very high for small, young individuals that are vulnerable to a wide range of predators. As these fish grow larger and older, they eventually outgrow the gape sizes of many predators, leading to a linear decrease in their predation mortality and a more stable total mortality rate.

298. (A) Steady-state baseline mass-balance established in Ecopath
ECOSIM is designed to explore the dynamic behavior of an ecosystem over time. It operates by using the static mass-balance snapshot established in ECOPATH as a baseline. The model then perturbs this steady state by simulating changes in fishing effort or environmental drivers. By observing how the biomass of various functional groups responds to these perturbations, researchers can evaluate the potential impacts of different management policies on the entire ecosystem structure.

299. (A) Truncate the size structure and reduce the proportion of mature females
The Length-Based Spawning Potential Ratio method is based on a fundamental principle of fishery dynamics. Intense fishing pressure typically targets larger individuals, which leads to a truncated size structure where fewer fish survive to reach older age classes. This reduction in the number of large, highly fecund mature females directly lowers the spawning potential of the population. By measuring this truncation in length data, the method provides an estimate of the overall stock health.

300. (B) Any individual, group, or organization with an interest in or influence over the fishery
In the context of an Ecosystem Approach to Fisheries Management, the term stakeholder is defined broadly to ensure all interests are

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284. (A) Observed weight to expected theoretical weight for that length
The relative condition factor is a specialized index used to assess the physiological well-being of a fish. It is calculated as the ratio of the actual observed weight of an individual to the weight that would be predicted for a fish of that length based on a population-specific length-weight relationship. This approach allows researchers to account for the unique growth patterns of different stocks, providing a more accurate measure of individual health.

285. (A) Unreliable due to the overlapping of length modes
Length-frequency analysis becomes increasingly difficult as fish get older. In many species, somatic growth in length slows down significantly once maturity is reached, while individuals continue to age. As a result, many different age classes end up having very similar lengths, causing the modal peaks in size histograms to overlap and become indistinguishable. This blurring makes it impossible to accurately estimate the age of older fish using length data alone.

286. (A) Fast-growing and short-lived
A high value for the curvature parameter K in the von Bertalanffy growth function is a clear indicator of a specific life history strategy. Species with high K values grow very rapidly when young and approach their maximum theoretical size at an early age. This rapid growth is generally associated with early maturity and short lifespans. These stocks often have high turnover rates and can be highly productive but may also be vulnerable to rapid depletion.

287. (A) Experienced by the fully recruited age classes represented in the descending limb
The total mortality rate estimated from a catch curve is specifically representative of the age classes that are fully vulnerable to the fishing gear. These are the individuals that appear in the descending right limb of the curve. The estimate assumes that the mortality and recruitment for these specific groups have been relatively constant over time. It does not reflect the mortality experienced by younger, incompletely recruited fish or the average over the entire lifespan.

288. (A) Low natural mortality
Hoenig's empirical method for estimating mortality is based on a fundamental biological relationship between lifespan and death rates. The method assumes that if a species has individuals that can reach a very high maximum observed age, its natural mortality rate must be inherently low. By formalizing this inverse relationship into a mathematical equation, Hoenig provided a reliable way to estimate mortality for many species where more detailed data on predation and disease are unavailable.

289. (A) Proportional increases in recruitment strictly tracking increases in spawner abundance
The ascending left limb of the Ricker stock-recruitment curve describes the phase where the population density is relatively low. In this range, density-dependent mortality is minimal, and the number of recruits increases proportionally with the number of spawners. This means that as more individuals contribute to the spawning biomass, the total production of recruits grows steadily, reflecting a positive relationship before the negative effects of overcrowding and cannibalism begin to dominate at higher stock levels.

290. (A) Zero or negative
The concept of environmental carrying capacity implies that there is a limit to the total biomass of a population that a specific habitat can sustain. When a population reaches or exceeds this threshold, the growth rate naturally drops to zero or even becomes negative. This happens because the intense competition for food, space, and other finite resources causes mortality to equal or exceed the combined gains from recruitment and growth, stabilizing the population.

291. (A) Extremely narrow
A sharp selection curve in a fishing gear study indicates that the transition from zero probability of capture to one hundred percent occurs over a very small range of fish lengths. Mathematically, this means that the selection range, which is the difference between the lengths at seventy-five percent and twenty-five percent retention, is extremely narrow. This indicates a high level of gear precision, where the mesh or hook size is very effective at selecting for a specific size.

292. (A) One half of carrying capacity
The Schaefer surplus production model is built on the mathematical properties of the logistic

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CHAPTER 04
Fishing Technology

2015

1. Which hull design is characterized by a flat bottom that provides high initial stability but pounds heavily in rough waters?
(A) Flat bottom hull
(B) Hard chine hull
(C) Round bilge hull
(D) V-bottom hull

2012

2. What term identifies the transverse curvature of the deck of a vessel designed to shed water overboard?
(A) Sheer
(B) Flare
(C) Camber
(D) Draft

2004

3. In vessel stability, the point through which the total upward buoyant force is considered to act is known as the center of what?
(A) Buoyancy
(B) Gravity
(C) Flotation
(D) Displacement

2013

4. Identify the INCORRECT statement regarding the Archimedes principle applied to vessel displacement.
(A) A floating vessel displaces a volume of water equal to its own weight.
(B) The weight of the displaced water determines the total displacement.
(C) Displacement includes the weight of the hull, machinery, and cargo.
(D) Buoyancy force acts downward against the hull.

2016

5. The distance between the waterline and the main deck of a vessel is referred to as which of the following?
(A) Draft
(B) Freeboard
(C) Keel depth
(D) Beam

2003

6. What structural component provides the primary longitudinal strength of a fishing vessel, acting as its backbone?
(A) Transom
(B) Bulkhead
(C) Keel
(D) Stringer

2008

7. Which hydrodynamic principle is most relevant when a planing hull rises above the water surface at high speeds?
(A) Static buoyancy
(B) Transverse stability
(C) Frictional drag
(D) Dynamic lift

2003

8. The tendency of a vessel to return to its original upright position after being heeled by an external force is defined as its what?
(A) Righting moment
(B) Reserve buoyancy
(C) Displacement coefficient
(D) Longitudinal trim

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2007

9. Select the most appropriate reason why round bilge hulls are commonly preferred for offshore fishing vessels.
(A) They are the cheapest to construct using basic flat timber.
(B) They offer lower resistance and smoother motion in a seaway.
(C) They have the highest initial stability in calm inland waters.
(D) They allow for maximum deck space due to perfectly vertical sides.

2003

10. Consider the following statements regarding vessel stability:
Assertion (A): A low center of gravity increases the metacentric height (GM) of a vessel.
Reason (R): Metacentric height is the distance between the center of gravity and the metacenter, and a larger GM generally means greater initial

268. (A) Attain maximum production at biomass levels below 50% of carrying capacity
The Fox surplus production model is characterized by its asymmetrical production curve, which differs from the symmetrical Schaefer model. It is designed to represent species where the maximum sustainable yield occurs at a lower biomass level, typically below fifty percent of the environmental carrying capacity. This makes the model more appropriate for certain types of stocks that exhibit different density-dependent responses to fishing pressure and population depletion.

269. (A) Somatic growth and total mortality
The Beverton-Holt yield-per-recruit model simulates the changes in the total biomass of a single cohort of fish as it ages. It integrates two competing biological processes: the increase in biomass due to the somatic growth of individuals and the decrease in the number of individuals due to total mortality. By finding the balance between these two rates, managers can determine the optimal fishing pressure and age at first capture to maximize the harvest.

270. (A) Instantaneously precisely in the middle of the year
Pope's cohort analysis is a simplified mathematical method for virtual population analysis that uses a discrete approximation of the continuous fishing process. It operates on the assumption that the entire annual catch is taken as a single, instantaneous pulse exactly halfway through the year. This simplification makes the calculations much more straightforward than the full exponential decay equations used in strict VPA, while still providing accurate results for most commercial fisheries.

271. (A) The harvest exactly matches the surplus production generated at that biomass level
The concept of Maximum Sustainable Yield is based on the assumption of equilibrium dynamics within a fish stock. At this state, the amount of fish harvested by the fishery is exactly equal to the surplus production, which is the net increase in biomass from growth and recruitment minus natural mortality. This balance allows the stock to be harvested at the same level indefinitely without causing the total biomass to increase or decrease over time.

272. (A) A limit reference point rather than a target due to inherent uncertainty
Modern fisheries management has increasingly shifted its view of F-MSY. While it was once considered a target to be aimed for, it is now more often treated as a limit reference point. This change reflects a growing awareness of the inherent uncertainties in stock assessments and the risk of overfishing. By treating F-MSY as a boundary not to be crossed, managers can provide a safer buffer for the long-term sustainability of stocks.

273. (A) Predation mortality by linking prey numbers to predator consumption demands
Multispecies virtual population analysis is a sophisticated tool that iteratively solves for the mortality rates within a complex ecosystem. It specifically calculates predation mortality by mathematically linking the numbers of prey species to the total consumption demands of their predators. By incorporating diet data, the model can estimate how much of each prey stock is eaten, providing a much more accurate and dynamic assessment of total mortality than single-species models.

274. (A) Ecotrophic Efficiency (EE) or Diet Composition
To construct a basic ECOPATH model, several key parameters are required for each functional group to achieve a mass balance. These typically include the group's biomass, its production-to-biomass ratio, and its consumption-to-biomass ratio. Additionally, the model requires either the ecotrophic efficiency or a detailed description of the group's diet composition. Together, these inputs allow the software to calculate the flow of energy and biomass through the entire ecosystem.

275. (A) $\frac{M}{K}$
The Length-Based Spawning Potential Ratio model is a valuable tool for assessing stocks with limited data, but it requires certain key assumptions. One of the most important is the ratio of the instantaneous natural mortality rate to the curvature parameter of the von Bertalanffy growth function. This M-to-K ratio reflects a fundamental life-history trade-off and is a critical input that determines the relationship between fish size and the relative spawning potential.

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2017

20. Consider the following boat building materials and their characteristics:

List I: (Boat Building Material)

P. Marine wood

Q. Steel

R. Aluminum

S. Ferro-cement

List II: (Characteristic)

1. Requires zinc anodes specifically to prevent rapid electrolytic decay when near other metals
2. Susceptible to Teredo and Martesia attack
3. Economical for one-off heavy displacement hulls in developing regions
4. Offers the highest impact resistance for heavy trawling

(A) P-2, Q-4, R-1, S-3
(B) P-3, Q-1, R-4, S-2
(C) P-2, Q-1, R-3, S-4
(D) P-1, Q-4, R-2, S-3

2021

21. Which material failure is specifically associated with the repeated flexing of an FRP hull over time?
(A) Osmosis blistering
(B) Delamination
(C) Dry rot
(D) Galvanic decay

2012

22. In wooden boat construction, the method of laying planks edge-to-edge to form a smooth outer hull is called what?
(A) Clinker build
(B) Lapstrake build
(C) Carvel build
(D) Cold molding

2001

23. What chemical compound was historically dominant in anti-fouling paints but is now globally banned due to severe environmental toxicity and imposex in marine gastropods?
(A) Cuprous oxide
(B) Zinc pyrithione
(C) Copper thiocyanate
(D) Tributyltin (TBT)

2004

24. Which technique involves attaching a more electrochemically active metal to a steel hull to protect it from corrosion?
(A) Cathodic protection with sacrificial anodes
(B) Active anodic passivation of steel surfaces
(C) Galvanizing through the hot-dip technique
(D) Impressed current anodic protection systems

2007

25. Identify the correct statement about wood preservatives used in marine crafts.
(A) Copper-chrome-arsenic (CCA) leaches rapidly and provides only temporary protection.
(B) Creosote is highly effective against borers but cannot be painted over.
(C) Oil-borne preservatives increase the natural buoyancy of wood.
(D) Water-borne preservatives make the wood highly flammable.

2002

26. In an impressed current cathodic protection (ICCP) system, what is actively supplied to the ship's hull to prevent corrosion?
(A) Sacrificial zinc ions
(B) Direct electrical current
(C) Anti-corrosive chemical inhibitors
(D) High-pressure freshwater

2001

27. The phenomenon of biological fouling on fishing vessels primarily causes which adverse effect?
(A) Increased drag and higher fuel consumption
(B) Significant rise in metacentric height
(C) Noticeable decrease in structural weight
(D) Enhanced stealth for acoustic monitoring

2014

28. Which metal is most commonly used as a sacrificial anode for vessels operating primarily in saltwater?
(A) Magnesium
(B) Aluminum
(C) Zinc
(D) Copper

2024

29. Copper oxide-based anti-fouling paints operate through which primary mechanism?
(A) Creating ultra-smooth surfaces to block adhesion
(B) Generating micro-electric fields across the paint
(C) Releasing oxygen bubbles to scrub the outer hull
(D) Controlled release of toxic ions to deter growth

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accommodate ocean swells and currents. To prevent the line from chafing on the seabed or snapping, what component is often integrated into the mooring design?
(A) A combination of sinking and floating ropes forming a catenary curve
(B) A continuous rigid steel pipe
(C) Solid concrete blocks suspended mid-water
(D) Explosive tension release bolts

2025
117. Payao is a traditional and highly successful type of FAD widely used in which region for tuna fishing?
(A) North Atlantic Ocean
(B) Mediterranean Sea
(C) Southeast Asia (Philippines, Indonesia)
(D) Baltic Sea

2002
118. Drifting FADs (dFADs) used by industrial tuna purse seiners are typically equipped with which modern technology to track them?
(A) AIS transmitters
(B) GPS buoys often integrated with echo sounders
(C) Heavy radar reflectors
(D) Underwater cameras

2023
119. Echo sounders calculate the depth of water and detect fish based on the measurement of:
(A) The frequency shift (Doppler effect) of continuous waves
(B) The time taken for an acoustic pulse to travel to the target and return
(C) The magnetic anomalies of the seabed
(D) The variation in water temperature

2004
120. Consider the following statements regarding the relationship between acoustic frequency and echo sounder performance:
I. Low-frequency signals penetrate deeper into the water column.
II. High-frequency signals provide higher target resolution.
III. Low-frequency signals are strongly attenuated in shallow water.
IV. High-frequency signals have shorter wavelengths.
V. A $200kHz$ transducer achieves greater depth penetration than a $38kHz$ transducer.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, III, IV and V
(C) II, III, IV and V
(D) I, II, III and V

2002
121. SONAR stands for:
(A) System Of Nautical Acoustic Ranging
(B) Sound Navigation And Ranging
(C) Surface Observation Navigation And Radar
(D) Sound Neutralizing And Ranging

2018
122. Unlike a standard echo sounder that directs its beam vertically downwards, an omnidirectional fisheries SONAR directs its acoustic beams in which manner?
(A) Vertically upwards to the surface
(B) Exclusively backwards toward the wake
(C) Only forward in a narrow 10-degree cone
(D) Horizontally around the vessel over 360 degrees

2014
123. The "Target Strength" (TS) of a fish detected by an echo sounder is primarily influenced by which anatomical feature?
(A) The presence and size of its gas-filled swim bladder
(B) The thickness of its scales
(C) The length of its fins
(D) The coloration of its skin

2002
124. Light fishing leverages the positive phototaxis of certain marine species. Which group is commercially targeted using this technique?
(A) Benthic flatfish
(B) Squids and small pelagics like sardines
(C) Deep-sea demersal sharks
(D) Scallops and oysters

2025
125. Potential Fishing Zones (PFZ) advisories in India are generated by INCOIS using remote sensing satellite data. Which two primary parameters are analyzed to identify these zones?
(A) Salinity and dissolved oxygen
(B) Sea Surface Temperature (SST) and Chlorophyll-a concentration
(C) Wave height and wind speed
(D) Ocean depth and bottom topography

2012
126. Global Positioning System (GPS) operates by calculating the vessel's position through:
(A) Trilateration of signals from at least four

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(A) I, II and IV
(B) I, III and IV
(C) II, III and IV
(D) I, II, III and IV

2004

41. If a twine is constructed with a final twist direction where the spirals run upward to the right, it is designated as which type of twist?
(A) S-twist
(B) Z-twist
(C) U-twist
(D) R-twist

2003

42. Twine made for fishing nets is generally produced using a three-stage twisting process. If the single yarns have an S-twist, what sequence is typically followed to ensure stability?
(A) S → S → Z
(B) S → Z → S
(C) Z → Z → S
(D) S → Z → Z

2025

43. Why is the English cotton count (Ne) considered an indirect numbering system?
(A) It measures 840-yard hanks per pound of yarn
(B) It calculates the diameter rather than weight
(C) Count numbers decrease as the yarn gets finer
(D) It uses optical scanning for yarn thickness

2013

44. What defines the "runnage" of a fishing twine?
(A) Breaking strength measured in kilograms
(B) Specific gravity of the polymer used
(C) Length of twine measured per unit weight
(D) Percentage of stretch before final break

2012

45. In knotting technology for netting, the most commonly used knot that resists slippage in synthetic materials is the:
(A) Reef knot
(B) Clove hitch
(C) Bowline
(D) Sheet bend (weaver's knot)

2001

46. Which measurement technique describes "mesh size" according to international standards for enforcement in trawl nets?
(A) Half the distance between two opposite knots
(B) The length of a single mesh bar
(C) Stretched distance between opposite knots
(D) Circumference of the open mesh perimeter

2013

47. The hanging ratio (E) of a fishing net is defined by the mathematical relationship:
(A) Length of the stretched netting divided by the length of the mounting rope
(B) Length of the mounting rope divided by the length of the stretched netting
(C) Mesh depth divided by mesh length
(D) Number of meshes divided by the twine thickness

2010

48. If a gillnet is mounted with a hanging ratio of 0.5, what is the geometric shape of the open meshes?
(A) Perfectly square
(B) Horizontally elongated diamond
(C) Symmetrical diamond where height and width are roughly equal
(D) Vertically elongated diamond

2008

49. The hanging coefficient influences the catching efficiency of gillnets. A tighter hanging (lower hanging ratio) is generally used to catch fish by which method?
(A) Entangling
(B) Gilling
(C) Wedging
(D) Trapping

2019

50. Consider the following parameters required to calculate the theoretical area of a fully rigged netting panel:
I. Hanging ratio (E)
II. Length of stretched netting
III. Twine twist direction
IV. Mesh bar length
V. Total number of meshes in depth
Which of the above statement(s) is/are correct?
(A) I, II, IV and V
(B) II, III, IV and V
(C) I, III, IV and V
(D) I, II, III and V

2016

51. The difference between a single sheet bend and a double sheet bend in net making is primarily for what purpose?
(A) To reduce knot slippage in slippery monofilament twines

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(C) Winching in the purse line running through rings at the bottom to close the net
(D) Lifting the entire net vertically out of the water

2012

95. What equipment revolutionized the handling of heavy purse seine nets, allowing for rapid hauling by mechanizing the pulling of the webbing?
(A) Net-sonde
(B) Puretic power block
(C) Otter board
(D) Gurdy

2004

96. Which hydrodynamic advancement in trawl design significantly reduces drag and fuel consumption without compromising the capture of fast-swimming pelagic species?
(A) Using heavy steel chains in the wings
(B) Using knotless micro-mesh throughout the net
(C) Attaching extra floats to the codend
(D) Using massive, super-large meshes or parallel ropes in the front section

2012

97. The angle of attack of an otter board determines its spreading force and drag. The optimal angle for maximum efficiency typically lies between:
(A) 5° to 10°
(B) 30° to 40°
(C) 60° to 70°
(D) 80° to 90°

2003

98. In trawl fishing, the length of the warp let out compared to the depth of the water is known as the:
(A) Hanging ratio
(B) Angle of incidence
(C) Warp-depth ratio (or Scope)
(D) Swept area

2003

99. Which of the following represents a passive fishing gear that consists of three layers of netting, where fish are caught by tangling in a pocket formed by a loose inner layer pushed through a larger outer mesh?
(A) Trammel net
(B) Cast net
(C) Stow net
(D) Drift gillnet

2024

100. Consider the following statements regarding gillnet operations:
I. They are highly size-selective.
II. Fish are caught mainly by wedging, gilling, or tangling.
III. They require high-speed towing to be effective.
Which of the above statement(s) is/are correct?
(A) I and II
(B) I and III
(C) II and III
(D) I, II and III

2004

101. Fish traps or pots are widely used to target benthic crustaceans. The entrance of the trap is typically designed as a:
(A) Square opening with no restriction
(B) Mechanized closing door triggered by weight
(C) Large mesh netting panel
(D) Tapered funnel to guide animals in and prevent escape

NODIA

2022

102. In bottom set longlines, how is the gear anchored to the seabed?
(A) By heavy trawl doors
(B) By anchors or weights attached to the ends of the mainline
(C) By driving wooden stakes into the mud
(D) By tying it to coastal mangroves

2025

103. The visibility of gillnet twines is a critical factor in catching efficiency. Therefore, modern commercial gillnets are mostly made of:
(A) Twisted cotton
(B) Heavy steel wire
(C) Transparent polyamide monofilament
(D) Brightly colored polyethylene multifilament

2022

104. Which fishing method exhibits the lowest environmental impact on the benthic ecosystem and yields fish of excellent quality?
(A) Bottom pair trawling
(B) Scallop dredging
(C) Handlining
(D) Beam trawling

2007

105. Green fishing practices aim to reduce the carbon footprint of fishing vessels. Which operational adjustment directly achieves this?
(A) Increasing towing speed to catch fish faster

2008

62. Which coastal state was the first primary operational base for the Indo-Norwegian Project?
(A) Gujarat
(B) Odisha
(C) Kerala
(D) Andhra Pradesh

2006

63. The transition from pure sail/oar propulsion to inboard marine diesel engines in traditional Indian designs was heavily promoted by which international organization alongside the INP?
(A) IMO
(B) FAO
(C) UNESCO
(D) WHO

2001

64. What was the major socioeconomic impact of the mechanization phase in Indian marine fisheries during the 1960s and 70s?
(A) Immediate eradication of all traditional non-motorized crafts
(B) Decline in total marine fish production
(C) Exclusive reliance on deep-sea foreign vessels
(D) Shift from subsistence fishing to commercial, export-oriented shrimp trawling

2024

65. The modernization of the Indian fishing fleet saw the widespread adoption of power take-off (PTO) systems. What is their primary function?
(A) To drive auxiliary deck machinery like winches from the main engine
(B) To generate electricity for the crew's cabin
(C) To automatically steer the vessel
(D) To regulate the vessel's buoyancy

2015

66. Under marine safety protocols, which item is classified as a personal Lifesaving Appliance (LSA)?
(A) Fire extinguisher
(B) VHF Radio
(C) Immersion suit
(D) Smoke detector

2012

67. The hydrostatic release unit (HRU) on a fishing vessel is an essential safety mechanism designed to automatically deploy which equipment?
(A) Inflatable liferafts
(B) Life jackets
(C) Fire hoses
(D) Emergency flares

2022

68. Identify the INCORRECT statement concerning marine pyrotechnic distress signals.
(A) Parachute flares are designed for long-range visibility.
(B) Hand flares should be held overboard on the leeward side.
(C) Pyrotechnics have a strict expiry date and must be replaced periodically.
(D) Smoke signals are highly effective for nighttime distress alerts.

2009

69. Firefighting Appliances (FFA) on board mechanized fishing vessels usually include portable extinguishers. A CO_2 extinguisher is most appropriate for which class of fire?
(A) Class A (Wood, paper)
(B) Class B and C (Flammable liquids and electrical fires)
(C) Class D (Combustible metals)
(D) Class K (Cooking oils)

2023

70. Determine the correct procedural sequence for activating a typical marine inflatable liferaft manually during an emergency abandon-ship scenario.
(A) Throw canister overboard → Pull painter line fully to inflate → Board liferaft → Cut painter line
(B) Pull painter line → Throw canister overboard → Cut painter line → Board liferaft
(C) Cut painter line → Throw canister overboard → Pull painter line → Board liferaft
(D) Board liferaft → Throw canister overboard → Pull painter line → Cut painter line

2016

71. An Emergency Position Indicating Radio Beacon (EPIRB) transmits distress signals primarily to which system?
(A) Terrestrial VHF towers
(B) Local coast guard radar
(C) Other fishing vessels' sonar
(D) Cospas-Sarsat satellite system

2018

72. Which safety device is required to be painted in a highly visible international orange color?
(A) Lifebuoys
(B) Trawl doors
(C) Fuel tanks
(D) Main engine block

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(B) To increase the mesh size
(C) To decrease the total weight of the net
(D) To allow faster machine weaving

2002

52. Knotless netting is frequently used in purse seines and aquaculture cages. What is its main advantage over knotted netting?
(A) It has a higher specific gravity.
(B) It is easier to mending manually with standard needles.
(C) It stretches indefinitely without breaking.
(D) It creates less hydrodynamic resistance and abrasion.

2006

53. Which traditional Indian fishing craft is essentially a log raft fashioned by lashing shaped logs together, primarily used on the surf-beaten East Coast?
(A) Masula
(B) Catamaran
(C) Machwa
(D) Dugout canoe

2010

54. The dugout canoe, historically common along the southwest coast of India, is constructed by which method?
(A) Planking over a pre-built frame
(B) Stitching palm leaves and coir together
(C) Hollowing out a single large log of wood
(D) Assembling multiple flat boards with wooden pegs

2012

55. What specific feature defines the "stitched boat" (e.g., the traditional Masula boat of Andhra Pradesh)?
(A) Planks are nailed to rigid steel frames.
(B) The hull is made of fiberglass sheets stitched with synthetic wire.
(C) The boat uses sails made of stitched animal skins.
(D) Planks are sewn together using coir ropes without rigid internal framing.

2022

56. Identify the motorized craft introduced extensively in India during the mechanization phase that features an outboard motor fitted to a traditional or slightly modified wooden/FRP hull.
(A) Motorized traditional craft (e.g., Vallam with OBM)
(B) Trawler
(C) Factory ship
(D) Purse seiner

2021

57. The "Teppa" or "Kattumaram" is predominantly utilized by artisanal fishers in which Indian coastal region?
(A) Gujarat
(B) Tamil Nadu
(C) Maharashtra
(D) West Bengal

2008

58. Plank-built boats of the northwest coast of India, such as the Satpati type, were traditionally characterized by which feature?
(A) Extremely narrow beam for speed
(B) Broad beam, deep draft, and a heavy wooden keel for stability in rough seas
(C) Complete lack of internal framing
(D) Outrigger attachments for stabilization

2008

59. Which type of traditional fishing craft makes use of a balance board or an outrigger to prevent capsizing?
(A) Outrigger canoe
(B) Flat-bottomed skiff
(C) Catamaran
(D) Masula

2002

60. Select the correct historical sequence of fishing craft evolution in India.
(A) Dugout canoes → Catamarans → Motorized traditional crafts → Mechanized trawlers
(B) Catamarans → Dugout canoes → Mechanized trawlers → Motorized traditional crafts
(C) Dugout canoes → Stitched boats → Motorized traditional crafts → Mechanized trawlers
(D) Stitched boats → Catamarans → Mechanized trawlers → Motorized traditional crafts

2011

61. The Indo-Norwegian Project (INP) initiated in 1952 played a pivotal role in the Indian fisheries sector by introducing:
(A) Deep-sea factory trawlers
(B) Satellite-based fish tracking
(C) Synthetic netting materials only
(D) Mechanized wooden boats and bottom trawling techniques

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2005

84. In riverine fishing, what is the primary function of a "barrier trap"?
(A) To actively chase fish upstream
(B) To entangle fish by their gills in a single wall of webbing
(C) To scoop fish out of shallow pools
(D) To guide migrating fish into a confined chamber where they cannot escape

2015

85. Deep-sea oceanic tuna longlining requires the bait to be set at specific depths. This depth is controlled primarily by adjusting the length of which component?
(A) Mainline
(B) Branch lines (snoods) and float lines
(C) Hook size
(D) Radio buoys

2002

86. Oceanic squid jigging operations utilize which specific attractant to gather squid around the vessel at night?
(A) Olfactory chumming
(B) Low-frequency acoustics
(C) High-intensity artificial lighting
(D) Live bait fish

2012

87. In mid-water (pelagic) trawling, how is the vertical opening of the net achieved and maintained?
(A) By heavy iron bobbins on the footrope
(B) By dragging the net along the seabed
(C) By using rigid steel frames at the net mouth
(D) By the balance of floats on the headline and weights/depressors on the footrope, combined with towing speed

2017

88. Mid-water trawlers utilize a specialized electronic device attached to the headline of the net to monitor the net's depth and fish entering the mouth. What is it called?
(A) Net-sonde
(B) Sonar buoy
(C) Echo sounder
(D) Radar

2013

89. In longline fishing, the device used to haul the mainline back onto the vessel is called a:
(A) Power block
(B) Line hauler
(C) Trawl winch
(D) Capstan

2001

90. Consider the following deep-sea fishing methods and their primary target species or features:
List I: (Fishing Method)
P. Tuna longlining
Q. Mid-water trawling
R. Squid jigging
S. Purse seining
List II: (Target Species or Feature)
1. Shoaling small pelagics like mackerel
2. Deep-swimming yellowfin and bigeye
3. Krill and pelagic schooling fish
4. Phototactic cephalopods
(A) P-2, Q-3, R-4, S-1
(B) P-1, Q-4, R-2, S-3
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

2002

91. A key structural difference between bottom trawls and mid-water trawls is that mid-water trawls generally:
(A) Lack heavy ground gear (like rockhoppers) and have a larger mouth opening
(B) Have much smaller mesh sizes in the wings
(C) Are always operated by two vessels (pair trawling) only
(D) Have no codend

2024

92. In an otter trawl system, what is the primary hydrodynamic function of the otter boards (trawl doors)?
(A) To sink the net to the bottom
(B) To filter out small by-catch
(C) To provide horizontal spreading force to keep the net mouth open
(D) To store the catch during towing

2007

93. Rigging of a bottom trawl requires a heavier footrope to maintain bottom contact. Which component is commonly used on rough seabeds to prevent net damage?
(A) Glass floats
(B) Kite depressors
(C) Sweep lines
(D) Rockhopper or bobbin gear

2016

94. The process of pursing in a purse seine operation involves:
(A) Hauling the floatline to collapse the net
(B) Towing the net at high speed to trap the fish

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2006

30. Consider the following methods used to maintain and protect marine wooden hulls:
I. Copper sheathing
II. Application of creosote
III. Spraying with hydrochloric acid
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2002

31. What is the primary purpose of applying a primer coat on a steel hull before the anti-fouling paint?
(A) Providing toxicity against barnacle settlement
(B) Barrier coat isolating steel from seawater
(C) Improving aesthetics and overall color depth
(D) Increasing flexibility of the hull plating

2016

32. Which synthetic polymer used in fishing gear floats in water due to having a specific gravity less than 1.0?
(A) Polyamide (PA)
(B) Polyester (PES)
(C) Polyvinyl alcohol (PVA)
(D) Polyethylene (PE)

2015

33. Identify the synthetic material known for its exceptional resistance to UV degradation and low stretch, making it ideal for pelagic trawl warps and longlines.
(A) Polyester (PES)
(B) Polypropylene (PP)
(C) Cotton
(D) Sisal

2004

34. Polyamide (PA), commonly known as nylon, exhibits which distinct characteristic when submerged in water?
(A) It gains significant tensile strength.
(B) It becomes completely rigid.
(C) It loses 10-20% of its tensile strength.
(D) Its specific gravity drops below 1.0.

2009

35. Natural fibers used in traditional fishing gears, such as cotton and manila, possess a major disadvantage compared to synthetics. What is it?
(A) Susceptibility to bacterial and fungal rotting
(B) High specific gravity in saltwater conditions
(C) Total inability to accept various fabric dyes
(D) Excessive elasticity under heavy fishing loads

2022

36. Which synthetic fiber has the highest melting point among the common polymers used in fishing nets?
(A) Polyethylene
(B) Polypropylene
(C) Polyvinyl chloride
(D) Polyamide

2012

37. What fundamental property distinguishes multifilament yarns from monofilament yarns in netting?
(A) Multifilaments consist of a single thick, solid continuous strand.
(B) Multifilaments are made by twisting multiple fine continuous filaments together.
(C) Multifilaments are only made from natural fibers.
(D) Multifilaments are exclusively transparent.

NODIA

2024

38. A yarn numbering system based on the weight in grams of a given length of yarn is classified as what type of system?
(A) Indirect system
(B) Metric system
(C) Direct system
(D) English system

2007

39. In the Tex system, the unit is defined as the mass in grams per how many meters of yarn?
(A) 100 meters
(B) 1,000 meters
(C) 9,000 meters
(D) 10,000 meters

2022

40. Consider the following statements regarding the yarn numbering systems used in fishing technology:
I. Denier is a direct system based on the weight in grams of 9,000 meters of yarn.
II. The metric count (Nm) is an indirect system based on meters per gram.
III. Tex is an indirect system based on length per unit mass.
IV. Runnage is a general term for the length of twine per unit weight.
Which of the above statement(s) is/are correct?

(B) Reducing hull fouling and optimizing engine RPM (steaming at economical speeds)
(C) Using heavier otter boards to keep the net steady
(D) Idling engines 24/7 to keep systems warm

2017
106. The adoption of semi-pelagic trawl doors is considered a "green" practice because:
(A) They fly entirely above the water surface.
(B) They operate just off the seabed, reducing bottom impact and drag.
(C) They are made of biodegradable wood.
(D) They automatically release juvenile fish.

2002
107. By-catch in fishing refers to which of the following?
(A) Capture of specific targeted adult fish
(B) Escapees through the mesh during towing
(C) Unintentional capture of non-target species
(D) Legal catch retained for sale at harbors

2001
108. A rigid grid By-catch Reduction Device (BRD) relies primarily on what characteristic to sort fish?
(A) The swimming speed of the fish
(B) The physical size and shape differences between target and non-target species
(C) The color preference of the fish
(D) The magnetic field of the species

2016
109. Which of the following is a soft-panel selective device used in trawls to allow juvenile finfish to escape?
(A) Nordmøre grid
(B) TED deflector bar
(C) Radial escape section
(D) Square mesh window (panel)

2025
110. Consider the following features of square mesh codends compared to traditional diamond mesh codends:
I. Square meshes remain open under tension during towing.
II. Square meshes allow better escapement of undersized round fish.
III. Square meshes significantly increase the total drag of the net.
IV. Square meshes do not distort when the catch accumulates.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, II and III
(C) II, III and IV
(D) I, III and IV

2006
111. Turtle Excluder Devices (TEDs) are mandated in many shrimp trawl fisheries. What is the fundamental component of a TED?
(A) An angled rigid grid of deflector bars leading to an escape opening
(B) A chemical repellent panel
(C) A high-intensity acoustic pinger
(D) A heavy leadline that drops the net bottom

2024
112. For a TED to effectively eject sea turtles while retaining shrimp, the grid is typically installed at an angle of approximately:
(A) 5° to 10°
(B) 40° to 55°
(C) 80° to 90°
(D) 120° to 150°

2014
113. The "Fisheye" is a type of BRD installed in trawl nets. Where is it typically placed?
(A) Near the otter boards
(B) At the very end of the codline
(C) On the footrope to jump over rocks
(D) On the top or side panels of the codend to allow finfish to swim out

2009
114. Shrimp excluder devices (like the radial escape section) take advantage of the behavioral difference between shrimp and fish. How do shrimp generally react when entering the trawl?
(A) They swim vigorously upwards.
(B) They are passively swept backward into the codend.
(C) They actively swim forward against the flow.
(D) They burrow into the mud.

2024
115. A Fish Aggregating Device (FAD) attracts pelagic fish based on their natural behavioral tendency to:
(A) Avoid light
(B) Associate with floating objects in the open ocean
(C) Follow magnetic lines
(D) Seek colder water layers

2002
116. Moored FADs require a robust anchoring system. The anchor line (mooring line) must

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2002

73. Which of the following is NOT a recognized visual distress signal under the International Regulations for Preventing Collisions at Sea (COLREGs)?
(A) A square flag having above or below it a ball
(B) A continuous flashing blue strobe light
(C) Continuous sounding with any fog-signaling apparatus
(D) Flames on the vessel

2016

74. According to FAO classification, which of the following gears is categorized as a "Surrounding Net"?
(A) Bottom otter trawl
(B) Purse seine
(C) Drift gillnet
(D) Trammel net

2014

75. Passive fishing methods rely on which fundamental principle to capture fish?
(A) The gear remains stationary and captures fish that move into it voluntarily.
(B) The gear is towed actively through the water to overtake the fish.
(C) The gear uses electrical currents to stun and pull fish inward.
(D) The gear drops from the surface, trapping fish directly beneath it.

2001

76. Which of the following gears is considered an active fishing method?
(A) Longline
(B) Pot/Trap
(C) Mid-water trawl
(D) Bottom set gillnet

2004

77. In the FAO gear classification system, "Falling Gear" predominantly refers to which type of net?
(A) Stow net
(B) Beach seine
(C) Stick-held dip net
(D) Cast net

2012

78. Dredges are specifically designed and classified to target which marine organisms?
(A) Pelagic shoaling fish
(B) Highly migratory tunas
(C) Benthic molluscs and scallops
(D) Deep-sea squids

2010

79. Inland reservoir fishing heavily relies on which passive gear due to irregular bottom topography and submerged obstacles?
(A) Bottom trawls
(B) Surface drift nets and set gillnets
(C) Purse seines
(D) Dredges

2016

80. Consider the following statements regarding bottom trawling in environmental regulations:
Assertion (A): Bottom trawling is generally prohibited or severely restricted in shallow riverine and estuarine environments.
Reason (R): Bottom trawling causes severe disturbance to the benthic substrate and destroys essential nursery habitats for fish and crustaceans.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

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2012

81. The "Coracle," a circular, bowl-shaped traditional craft made of interwoven split bamboo covered with hides or plastic, is widely used in which aquatic environment?
(A) Inland rivers and reservoirs of southern India
(B) Offshore marine waters
(C) Deep-sea canyons
(D) Coastal backwaters of Gujarat

2009

82. Which specialized gear is commonly used in estuarine environments to filter catch utilizing strong tidal currents?
(A) Cast net
(B) Tuna longline
(C) Stake net (Stow net)
(D) Handline

2001

83. The operation of a "Dol net" along the northwest coast of India is entirely dependent on what environmental factor?
(A) Tidal currents
(B) Wind speed
(C) Photic depth
(D) Benthic vegetation

satellites
(B) Reflection of radio waves off the ionosphere
(C) Acoustic ranging from coastal beacons
(D) Magnetic variation from the North Pole

2002
127. Vessel Monitoring Systems (VMS) are primarily installed on commercial fishing vessels for what purpose?
(A) To increase the engine's fuel efficiency
(B) To actively scan the seabed for obstacles
(C) To broadcast the vessel's catch data to nearby competitors
(D) To allow regulatory authorities to track vessel location, speed, and course for compliance

2012
128. Which communication equipment is standard for short-range voice communication (ship-to-ship and ship-to-shore) in coastal fisheries?
(A) INMARSAT
(B) VHF Radiotelephone
(C) EPIRB
(D) HF SSB Radio

2008
129. The Automatic Identification System (AIS) transmits vessel data via VHF frequencies. Which of the following data is NOT typically transmitted by AIS?
(A) Real-time fuel tank level
(B) Vessel name and MMSI number
(C) Current speed and course over ground
(D) Vessel navigational status

2007
130. Select the correct operational sequence of data flow for a PFZ advisory to reach a fisherman.
(A) Satellite captures data → INCOIS processes data into maps → Information disseminated via SMS/boards to harbors → Fisherman navigates to coordinates
(B) Fisherman calls INCOIS → Satellite scans the requested area → INCOIS prints map → Fisherman navigates
(C) INCOIS processes data → Satellite receives data → Fisherman sends SMS → Harbor translates data
(D) Fisherman navigates → Satellite records catch → INCOIS validates location → SMS sent to harbor

2011
131. Inland fishing techniques often employ "stake nets." These are most effective in waters that exhibit:
(A) Strong tidal flows to push fish into the net
(B) Absolute stagnation
(C) High turbidity with zero flow
(D) Extremely deep bathymetry

NODIA

2012
132. Which feature represents the primary advantage of synthetic materials over natural fibers in modern net construction?
(A) Higher resistance to rotting and degradation
(B) Lower cost of raw botanical materials
(C) Biodegradability if lost at sea
(D) Increased specific weight for faster sinking

2013
133. When measuring the pulling strength of a winch, the term "bollard pull" is often used. Bollard pull is essentially a measure of a vessel's:
(A) Total displacement
(B) Maximum towing force
(C) Braking distance
(D) Lateral stability

2001
134. Which material is most susceptible to deterioration from prolonged exposure to ultraviolet (UV) light if not properly treated or dyed?
(A) Polyester
(B) Polypropylene (PP)
(C) Polyamide (Nylon)
(D) Polyethylene

2001
135. Identify the INCORRECT statement regarding the handling of fishing catch on board.
(A) Immediate chilling reduces bacterial spoilage.
(B) Rough handling can cause bruising and degrade flesh quality.
(C) Storing catch in deep, unpartitioned bulk holds minimizes crushing.
(D) Bleeding certain fish (like tuna) improves meat color and quality.

2009
136. What is the fundamental purpose of a breakwater in a fishing harbor?
(A) To absorb and reflect wave energy, providing a calm basin for vessels
(B) To filter pollutants from harbor water
(C) To serve as the primary auction hall for fish
(D) To generate hydroelectric power for the harbor

2016
137. In harbor terminology, what is a "quay"?

2021
201. Which term describes a fishing practice that complies with the FAO Code of Conduct for Responsible Fisheries?
(A) Sustainable or responsible fishing
(B) Destructive fishing
(C) IUU fishing
(D) Ghost fishing

2006
202. IUU fishing is a major global threat to marine resources. What does the acronym IUU stand for?
(A) Illegal, Unreported, and Unregulated
(B) International, Undocumented, and Unregulated
(C) Inland, Underwater, and Unrestricted
(D) Irregular, Unmanaged, and Unauthorized

2003
203. A "Rigid Sorting Grid" like the Nordmøre grid was originally developed in Norway to separate:
(A) Shrimp from by-catch of cod and haddock
(B) Tuna from dolphins
(C) Crabs from lobsters
(D) Squid from jellyfish

2005
204. The Medina panel is a specific modification in purse seine nets designed to:
(A) Prevent the entanglement of dolphins and facilitate their escape
(B) Catch larger tuna
(C) Prevent the net from sinking
(D) Sort different species of shrimp

2003
205. Acoustic deterrent devices (pingers) have successfully reduced the incidental by-catch of which marine mammal in gillnet fisheries?
(A) Harbor porpoises
(B) Blue whales
(C) Manatees
(D) Sea lions

2024
206. Hook design modifications, such as avoiding J-hooks, and altering bait types (e.g., using fish instead of squid) are major mitigation measures to reduce the by-catch of:
(A) Pelagic seabirds (like albatrosses) and sea turtles
(B) Jellyfish
(C) Deep-sea sponges
(D) Benthic crabs

2014
207. A "Tori line" or bird-scaring line is deployed during longline setting to:
(A) Frighten seabirds away from diving onto baited hooks before they sink
(B) Catch birds for bait
(C) Guide the hooks deep into the water immediately
(D) Act as an antenna for the radio beacon

2013
208. FADs can be highly productive but ecological concerns are rising regarding their use. What is a major ecological concern associated with drifting FADs in tuna fisheries?
(A) They significantly increase the by-catch of juvenile tuna and non-target species like sharks.
(B) They cause the ocean temperature to rise.
(C) They generate large amounts of acoustic noise.
(D) They prevent phytoplankton from photosynthesizing.

2025
209. To combat the issue of marine plastic pollution, researchers advocate for dFADs to be constructed using:
(A) Biodegradable materials like bamboo, palm leaves, and cotton ropes
(B) Ultra-thick PVC plastics
(C) Solid aluminum blocks
(D) Kevlar and carbon fiber

2007
210. Consider the following gear components and their corresponding fishing gears:
List I: (Gear Component)
P. Otter board
Q. Purse line
R. Snood
S. Tickler chain
List II: (Fishing Gear)
1. Longline
2. Beam trawl
3. Purse seine
4. Otter trawl
(A) P-4, Q-3, R-1, S-2
(B) P-3, Q-4, R-2, S-1
(C) P-2, Q-1, R-4, S-3
(D) P-1, Q-2, R-3, S-4

2024
211. Which characteristic defines an "eco-friendly" fishing gear?
(A) High size and species selectivity with low

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2002

149. The main deck of a vessel designed to allow water to quickly drain overboard uses openings known as:
(A) Hatch coamings
(B) Scuppers or freeing ports
(C) Companionways
(D) Bilge keels

2012

150. Consider the following statements regarding metal isolation in vessels:
Assertion (A): Aluminum vessels require special isolation when fitted with bronze propellers or steel fittings.
Reason (R): Direct contact between dissimilar metals in seawater creates a galvanic cell, leading to severe corrosion of the less noble metal (aluminum).
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2008

151. Which principle governs the operation of a "torpedo" or "kite" used in pelagic trawling?
(A) Hydrodynamic lift
(B) Static buoyancy
(C) Acoustic repulsion
(D) Magnetic attraction

2015

152. In net webbing terminology, what does the term "bating" mean?
(A) Adding bait to the net
(B) Decreasing the number of meshes in a row to taper the net
(C) Increasing the mesh size towards the codend
(D) Treating the net with preservatives

2010

153. What does "creasing" mean when constructing or shaping a fishing net?
(A) Folding the net for storage
(B) Increasing the number of meshes in a row to widen the panel
(C) Melting the knots to prevent slippage
(D) Sewing two panels edge-to-edge

2008

154. If a netting panel is cut "all bars" (an AB cut), what is the resulting shape of the cut edge?
(A) It forms a straight diagonal edge.
(B) It forms a completely straight horizontal edge.
(C) It forms a completely straight vertical edge.
(D) It creates a zig-zag pattern parallel to the meshes.

2006

155. A straight cut across the width of the netting, cutting two bars of every mesh (N-cut or T-cut), progresses in which direction?
(A) Transversely (horizontally across the meshes)
(B) Longitudinally (vertically down the meshes)
(C) Diagonally
(D) In a circular pattern

NODIA

2013

156. The drag of a trawl net is heavily influenced by the total surface area of the netting twines. Which formula estimates the resistance of netting towed through water?
(A) Archimedes' principle
(B) Newton's law of cooling
(C) Newtonian drag equation ($R = \frac{1}{2} C_d \rho A v^2$)
(D) Bernoulli's equation

2008

157. Which environmental factor causes the rapid degradation of natural fiber twines like cotton when left damp?
(A) Microbial degradation (cellulose-digesting bacteria and fungi)
(B) Oxidation by atmospheric nitrogen
(C) Galvanic corrosion
(D) UV polymerization

2025

158. In the construction of synthetic ropes, "laid" rope refers to strands twisted together, whereas "braided" rope refers to:
(A) Strands interwoven in a tubular or solid pattern
(B) Strands glued together
(C) A single solid filament extruded from a die
(D) Fibers melted into a solid core

2017

159. What is the most significant advantage of using braided twines over twisted twines in the construction of large pelagic trawl nets?
(A) They resist untwisting and kinking under heavy tension.
(B) They are cheaper to produce.
(C) They have absolutely zero drag.
(D) They float natively without needing floats.

III. Weight in water
IV. Color of the board
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) II, III and IV
(C) I, II and III
(D) I, III and IV

2006
181. A high aspect ratio otter board (taller than it is long) generally has what hydrodynamic characteristic compared to a low aspect ratio board?
(A) Higher lift-to-drag ratio, making it more efficient
(B) Lower spreading force and higher drag
(C) Extreme instability and impossibility to tow
(D) It requires no warps to function

2024
182. V-shaped otter boards are widely used in bottom trawling because they:
(A) Are highly stable and can easily override bottom obstacles without falling over flat
(B) Ride entirely above the water
(C) Create zero drag
(D) Trap fish within their structure

2016
183. Beam trawling utilizes a rigid beam to hold the net open. This method is predominantly utilized for catching:
(A) Benthic flatfish like sole and plaice
(B) Fast-swimming tuna
(C) Pelagic schooling fish
(D) Mid-water squid

2019
184. The "chain matrix" or tickler chains on a beam trawl are highly effective for flatfish but face heavy criticism due to:
(A) Causing severe physical impact and plowing of the benthic ecosystem
(B) Catching too many seabirds
(C) Emitting toxic chemicals into the water
(D) Releasing excessive greenhouse gases

2025
185. Electric pulse trawling replaces heavy tickler chains with electrical pulses to startle flatfish. What is its main environmental advantage over traditional beam trawling?
(A) It significantly reduces seabed disturbance and fuel consumption.
(B) It completely eliminates all by-catch.
(C) It sterilizes the seabed, preventing disease.
(D) It works without any vessel propulsion.

2023
186. Surrounding nets (purse seines) heavily depend on the sinking speed of the net to prevent fish from escaping underneath. To maximize sinking speed, the net is typically rigged with:
(A) Heavy lead weights on the bottom line (leadline)
(B) Excessively large floats
(C) Thicker, more buoyant twines
(D) Parachutes on the leadline

2009
187. In a purse seine, the "bunt" is best described as:
(A) The reinforced section of netting where the catch is concentrated before brailing
(B) The leading edge of the net towed by the skiff
(C) The metal rings at the bottom of the net
(D) The rope used to pull the net closed

2023
188. "Brailing" is a term used in purse seining and refers to:
(A) Transferring the concentrated fish from the bunt of the net onto the vessel using a large scoop net or fish pump
(B) Tying the knots in the netting
(C) Sewing holes in the net
(D) Deploying the net from the stern

2016
189. A purse seine operation typically involves a small auxiliary boat called a:
(A) Skiff
(B) Tug
(C) Trawler
(D) Coracle

2002
190. Consider the following features of traditional passive fishing gears like pots and traps:
I. Low energy consumption during fishing
II. High catch quality due to fish remaining alive
III. Massive destruction of the benthic environment
IV. High species selectivity based on trap design
V. Dependency on fish behavior (e.g., scavenging for bait)
Which of the above statement(s) is/are correct?
(A) I, II, IV and V
(B) II, III, IV and V
(C) I, III, IV and V
(D) I, II, III and V

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netting panel

2018

170. Consider the following properties of ultra-high-molecular-weight polyethylene (UHMWPE) for modern trawl warps instead of steel wire:
I. Higher strength-to-weight ratio than steel
II. Positive buoyancy (it floats)
III. High susceptibility to rust
Which of the above statement(s) is/are correct?
(A) I and II
(B) I and III
(C) II and III
(D) I, II and III

2006

171. The legal "mesh size" regulation in fisheries is an input control primarily designed to:
(A) Ensure the net sinks rapidly
(B) Allow juvenile and undersized fish to escape and reach reproductive maturity
(C) Reduce hydrodynamic drag
(D) Prevent marine mammals from approaching the gear

2022

172. According to standard maritime conventions, which flag state is primarily responsible for the implementation of safety protocols on a fishing vessel?
(A) The state where the fish are sold
(B) The state under whose flag the vessel is registered
(C) The state whose territorial waters the vessel is in
(D) The state where the vessel was manufactured

2025

173. What is the minimum number of lifebuoys typically required on a small mechanized fishing vessel (under 24m) per safety standards?
(A) 2
(B) 4
(C) 10
(D) 20

2014

174. Which fire-extinguishing agent is most dangerous to use on a live electrical fire on board?
(A) CO_2
(B) Solid stream of water
(C) Dry Chemical Powder
(D) Clean agent gas

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2006

175. The "Bilge system" of a fishing vessel is designed to:
(A) Pumping out water and oil from the lower inner hull
(B) Storing fresh drinking water for the onboard crew
(C) Circulating seawater through specialized bait tanks
(D) Providing high-pressure water for firefighting use

2024

176. Which condition leads to the "free surface effect" which dangerously reduces a vessel's stability?
(A) Partially filled tanks or fish holds where liquids can slosh from side to side
(B) A completely full and sealed fuel tank
(C) Ice formation on the upper superstructures
(D) Operating in perfectly calm waters

2024

177. The term "icing" in northern latitude fisheries poses a catastrophic hazard to vessel stability because:
(A) The added weight of ice on the superstructure drastically raises the center of gravity
(B) It reduces engine temperature
(C) It freezes the propeller shaft
(D) It causes the hull to shrink

2012

178. What does the term "trim" refer to in the context of vessel stability?
(A) The difference between the forward and aft drafts
(B) The transverse inclination or list of the vessel
(C) The width of the vessel at its widest point
(D) The aesthetic paintwork on the sheer line

2001

179. A fishing vessel is said to be "trimming by the stern" when:
(A) The draft aft is greater than the draft forward
(B) The draft forward is greater than the draft aft
(C) The vessel is perfectly level
(D) The vessel is tilted to the starboard side

2009

180. Consider the following factors contributing to the design and performance of an otter board:
I. Angle of attack
II. Aspect ratio (height to length)

(A) A floating buoy used for mooring
(B) A slipway for repairing boats
(C) A solid, stationary structure parallel to the shoreline for loading and unloading
(D) A navigational light at the harbor entrance

2012
138. Which infrastructural component is essential at a fish landing center to maintain the cold chain?
(A) Ice plants and cold storages
(B) Net mending sheds
(C) Dry docking facilities
(D) Bunkering stations

2019
139. The choice of site for a fishing harbor must carefully evaluate littoral drift. What is littoral drift?
(A) The movement of fish schools along the coast
(B) The transport of sand and sediment along the coast by wave action
(C) The deviation of the magnetic compass near land
(D) The prevailing coastal wind direction

2024
140. Arrange the typical stages of a commercial marine fishing operation in the correct sequence.
I. Steaming to the fishing ground
II. Sorting and chilling the catch
III. Setting/shooting the gear
IV. Hauling the gear
V. Unloading at the harbor
(A) I → III → IV → II → V
(B) III → I → IV → II → V
(C) I → IV → III → II → V
(D) I → III → II → IV → V

2022
141. The use of "chilled sea water" (CSW) on fishing vessels involves mixing which components in the fish hold?
(A) Fresh water, salt, and liquid nitrogen
(B) Sea water, crushed ice, and the fish catch
(C) Sea water and chemical preservatives
(D) Mechanically refrigerated sea water without ice

2002
142. A slipway in a fishing harbor is primarily designed for:
(A) Discharging liquid fish waste
(B) Launching and hauling out vessels for repair and maintenance
(C) Quick transfer of fish boxes to trucks
(D) Refueling smaller crafts

2023
143. Which environmental issue is most directly caused by the loss of synthetic fishing nets in the ocean?
(A) Ocean acidification
(B) Ghost fishing
(C) Harmful algal blooms
(D) Ozone layer depletion

2024
144. To mitigate "ghost fishing," modern fisheries management sometimes mandates the use of:
(A) Stainless steel traps
(B) Biodegradable escape panels or rot cords in traps
(C) Thicker, unbreakable netting twines
(D) Acoustic pingers that never turn off

2016
145. An acoustic pinger attached to a gillnet is an active deterrent primarily designed to prevent the entanglement of:
(A) Demersal sharks
(B) Marine mammals (e.g., dolphins and porpoises)
(C) Benthic crabs
(D) Seabirds

2004
146. A "jig" used in squid fishing is characterized by having:
(A) A single, large baited hook
(B) A crown of unbarbed hooks (prongs) surrounding a lure
(C) A small treble hook with live bait
(D) A mechanical snapping jaw

2022
147. What type of vessel propulsion system provides the highest maneuverability, often eliminating the need for a conventional rudder?
(A) Fixed pitch propeller
(B) Kort nozzle
(C) Azimuth thruster (Z-drive)
(D) Paddle wheel

2018
148. The primary advantage of enclosing a propeller in a Kort nozzle on a trawler is to:
(A) Increase bollard pull and towing efficiency at low speeds
(B) Increase top steaming speed
(C) Reduce engine noise
(D) Prevent entanglement with surface debris

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2011

191. Lift nets use a fundamental capture principle involving:
(A) Submerging a horizontal net, congregating fish above it (often with light/bait), and rapidly lifting it out of the water
(B) Chasing fish into a funnel
(C) Towing a net vertically through the water column
(D) Entangling fish by their gills

2007

192. The "Chinese dip net" found extensively in Kochi, India, is an example of which gear category?
(A) Shore-operated lift net
(B) Falling gear
(C) Trawl net
(D) Dredge

2018

193. Beach seines are traditional gears characterized by:
(A) A net shot in a semi-circle from the shore and hauled entirely onto the beach by hand or winches
(B) Being operated in the deep ocean, thousands of miles offshore
(C) Relying exclusively on acoustic pingers
(D) Using highly mechanized factory vessels

2025

194. The catching efficiency of a hook-and-line gear is heavily dependent on the design of the hook. A "circle hook" is increasingly mandated in longline fisheries because:
(A) It causes less deep hooking (gut hooking) in turtles and fish, improving post-release survival.
(B) It is cheaper to manufacture than J-hooks.
(C) It dissolves in water after 24 hours.
(D) It perfectly fits the mouth of every marine species.

2003

195. Bait used in commercial longlining is generally classified into two types: natural and artificial. Which of the following is a common natural bait for pelagic longlining?
(A) Squid and saury
(B) Colored plastic skirts
(C) Metal spoons
(D) Wooden plugs

2005

196. The Snood (or branch line or gangion) in a longline connects the hook to the mainline. To prevent the snood from twisting and tangling due to a spinning hooked fish, what component is integrated?
(A) A swivel
(B) A heavy lead weight
(C) A float
(D) A square mesh panel

2004

197. Troll lines (trolling) involve:
(A) Towing multiple baited hooks or lures near the surface behind a moving vessel
(B) Setting stationary lines on the seabed
(C) Dropping a single line vertically into deep water
(D) Entangling fish in a drifting net

2022

198. Pole-and-line fishing is highly celebrated as an eco-friendly method. What is its primary commercial target species globally?
(A) Skipjack and small yellowfin tuna
(B) Deep-sea anglerfish
(C) Benthic flatfish
(D) Scallops

2016

199. A critical component of a successful pole-and-line operation is "chumming." What does chumming entail?
(A) Throwing live baitfish into the water to whip the target school into a feeding frenzy
(B) Creating loud noises on the hull
(C) Spraying chemical attractants
(D) Shining bright lights underwater

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2023

200. Consider the following statements regarding square mesh panels in trawl codends:
Assertion (A): Square mesh panels are highly effective as By-catch Reduction Devices (BRDs) in trawl codends.
Reason (R): Under towing tension, diamond meshes tend to close up and block escapement, whereas square meshes remain fully open regardless of tension.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2022

160. Consider the following navigation/communication tools and their marine functions:

List I: (Navigation/Communication Tool)

P. RADAR

Q. GPS

R. Echo Sounder

S. VHF Radio

List II: (Marine Function)

1. Determining the exact global latitude and longitude
2. Detecting surface vessels, landmasses, and obstacles in low visibility
3. Short-range ship-to-ship voice communication
4. Determining depth and detecting submerged fish

(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-2, Q-4, R-1, S-3
(D) P-3, Q-1, R-4, S-2

2011

161. A "Trawl Eye" (or Net-sonde) displays several key parameters to the skipper. Which of the following is it NOT designed to show?

(A) The distance of the headrope to the surface
(B) The distance of the footrope to the bottom
(C) The temperature of the main engine
(D) Fish entering the mouth of the trawl

2009

162. How does the concept of "swept area" relate to fisheries stock assessment?

(A) Seabed area covered to estimate fish biomass
(B) Total deck area utilized for sorting the catch
(C) Geographical area of the designated harbor
(D) Ocean surface area allocated to the country

2006

163. The term "Target Catch" refers to:

(A) Specific species the gear and operation are designed to catch
(B) All organisms brought on deck during the hauling process
(C) Protected species that are legally required to be released
(D) Low-value fish retained for use as bait or chum

2022

164. What defines a "high-opening bottom trawl"?

(A) Trawl specifically used at the surface
(B) Bottom trawl designed with modified wings and flotation to achieve greater vertical height, targeting semi-pelagic species
(C) A trawl with excessively large meshes in the codend
(D) A trawl operated without any otter boards

2012

165. Pair trawling involves two vessels towing a single net. What major piece of equipment, essential for a single-vessel trawl, is completely eliminated in this method?

(A) Winches
(B) Warps
(C) Otter boards
(D) Codend

2015

166. A significant advantage of pair trawling over single-vessel otter trawling is:

(A) It eliminates engine noise over the net, reducing fish startle responses.
(B) It requires less total fuel than a single small vessel.
(C) It can be operated safely in extremely shallow, rocky rivers.
(D) It requires no communication between vessels.

2012

167. "Outrigger trawling," widely known as the Gulf of Mexico rig, is specifically utilized for targeting:

(A) Benthic shrimp
(B) Deep-sea cod
(C) Pelagic tuna
(D) Mid-water squid

2006

168. In outrigger shrimp trawling, vessels often tow a small "try net" alongside the main nets. What is its purpose?

(A) Sampling the bottom to estimate shrimp abundance
(B) Cleaning the seabed ahead of the primary nets
(C) Catching small fish for consumption by the crew
(D) Acting as a sea anchor for stabilizing the vessel

2014

169. What is the fundamental principle of a "tickler chain" rigged ahead of a trawl's footrope?

(A) Disturbing sediment to force organisms into the net
(B) Increasing the buoyancy of the heavy footrope line
(C) Measuring the actual speed of the vessel over ground
(D) Breaking large boulders to protect the

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carbon emission per kg of catch
(B) Low target catch efficiency
(C) High impact on benthic structures
(D) Made entirely of non-degradable synthetic plastics

2025
212. In the design of a turtle excluder device (TED), if the deflector bars are spaced too widely, what is the consequence?
(A) Small turtles fail to be excluded and pass into the codend.
(B) It becomes too heavy.
(C) It excludes all the target shrimp.
(D) It causes the net to collapse.

2023
213. The "escape gap" in a lobster pot is designed specifically to:
(A) Let small, undersized lobsters walk out while retaining legal-sized ones
(B) Allow water to flow freely
(C) Allow predators to enter and eat the bait
(D) Make the pot easier to haul

2007
214. The yarn numbering system known as "Denier" is defined as which of the following?
(A) Mass in grams of 9,000 meters of yarn
(B) Mass in grams of 1,000 meters of yarn
(C) Length in meters of 1 gram of yarn
(D) Braking strength in kilograms

2011
215. What is the equivalent metric count (Nm) if 50,000 meters of a single yarn weigh exactly 1 kilogram?
(A) Nm 10
(B) Nm 50
(C) Nm 100
(D) Nm 500

2014
216. The specific gravity of Polypropylene (PP) is approximately 0.91. How does this affect its behavior in water?
(A) It sinks very rapidly.
(B) It remains perfectly suspended in mid-water.
(C) It floats on the surface.
(D) It dissolves after a few hours.

2004
217. Identify the principal reason why Kevlar (Aramid) is rarely used for regular trawl netting despite its immense tensile strength.
(A) It has very poor resistance to abrasive wear and flex fatigue, and is highly expensive.
(B) It has a specific gravity less than water.
(C) It is highly elastic.
(D) It melts in cold seawater.

2004
218. In net making terminology, what is a "mesh bar"?
(A) The full perimeter of the mesh
(B) The distance between two adjacent knots (one side of the mesh)
(C) The diagonal distance across the mesh
(D) The tool used to tie the knot

2014
219. To calculate the amount of twine required to make a netting panel, one must estimate the weight. Which geometric component dictates the bulk of the weight in knotted netting?
(A) The knots, which can account for a significant percentage of the total weight
(B) The mesh bars only
(C) The selvage
(D) The mounting rope

2001
220. Consider the following statements regarding the construction of bottom trawl codends:
Assertion (A): High-density polyethylene (HDPE) is the most common material used for the construction of bottom trawl codends.
Reason (R): HDPE possesses excellent abrasion resistance, which protects the codend as it drags across the seabed.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2003
221. The selvage of a fishing net refers to:
(A) The reinforced, thicker meshes at the edges of a netting panel meant to take extra strain
(B) The center-most meshes of the net
(C) The damaged meshes that need repair
(D) The chemical dip applied to the net

2017
222. When mounting a netting panel to a rope, the operation is often called:
(A) Hanging
(B) Braiding
(C) Mending
(D) Splicing

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2016

223. What is the fundamental difference between a sheet bend and a reef knot when joining two ropes?
(A) A sheet bend is superior for joining two ropes of unequal diameter.
(B) A reef knot is stronger when wet.
(C) A reef knot is strictly for synthetic fibers.
(D) A sheet bend cannot be untied.

2017

224. Splicing a rope is preferred over knotting because:
(A) A properly made splice retains a much higher percentage of the rope's original breaking strength than a knot.
(B) It is much faster to do.
(C) Splices can be undone instantly.
(D) Splices require no tools.

2024

225. An eye splice is used to:
(A) Form a permanent loop at the end of a rope
(B) Join two separate ropes end-to-end
(C) Prevent the end of a rope from fraying (whipping)
(D) Attach a hook to the middle of a line

2022

226. In wooden boat maintenance, what is "caulking"?
(A) Forcing oakum or cotton into the seams between hull planks to make them watertight
(B) Painting the deck
(C) Polishing the brass fittings
(D) Replacing the engine oil

2010

227. Copper-based anti-fouling paints are strictly regulated but permitted, whereas TBT paints are globally banned by the IMO. In what year did the total global ban on the application of TBT on ships come into full effect?
(A) 1980
(B) 1990
(C) 2003 (with full phase-out by 2008)
(D) 2020

2023

228. Sacrificial anodes must be electrically connected to the metal they are protecting. If a vessel is taken out of the water, the cathodic protection system:
(A) Ceases to function because the seawater electrolyte is missing
(B) Continues to work efficiently through the air
(C) Causes spontaneous combustion
(D) Reverses polarity

2011

229. Wood borers like Teredo navalis are commonly referred to as:
(A) Shipworms
(B) Barnacles
(C) Limnoria
(D) Tube worms

2010

230. Consider the following marine acoustic instruments and their primary modes of operation or targets:
List I: (Marine Acoustic Instrument)
P. Transducer
Q. Net-sonde
R. Omnidirectional SONAR
S. ADCP (Acoustic Doppler Current Profiler)
List II: (Mode of Operation/Target)
1. Scans 360 degrees around the vessel to find pelagic schools
2. Converts electrical energy to acoustic energy and vice versa
3. Measures water current velocities over a depth range
4. Mounted on the trawl net to monitor mouth opening and catch
(A) P-2, Q-4, R-1, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-1, R-3, S-4

NODIA

2008

231. The frequency of an echo sounder affects the cone angle of the acoustic beam. Generally, a higher frequency transducer (e.g., $200kHz$) compared to a lower frequency one ($50kHz$) of the same physical size will produce:
(A) A narrower, more focused beam angle
(B) A much wider beam angle
(C) An identical beam angle
(D) A square beam pattern

2011

232. To accurately estimate the total biomass of a fish school using scientific echo sounders, which technique is utilized?
(A) Echo integration
(B) Echo counting
(C) Single beam tracking
(D) Visual estimation

2016

233. The "blind zone" (or dead zone) in an echo sounder is a critical limitation where fish cannot be detected. Where does this zone typically occur?

(A) Immediately above a sloping or rough seabed
(B) Directly at the sea surface
(C) In the middle of the water column
(D) Inside the fish hold

2018
234. In acoustic terminology, what is a "ping"?
(A) A single pulse of acoustic energy transmitted by the transducer
(B) The continuous sound of the engine
(C) The physical impact of the trawl door on rocks
(D) The alarm sound for shallow water

2003
235. The velocity of sound in seawater is a critical constant for depth calculation in echo sounders. What is the approximate average velocity of sound in seawater?
(A) $340 m/s$
(B) $1{,}000 m/s$
(C) $1{,}500 m/s$
(D) $3{,}000 m/s$

2002
236. Which factor significantly increases the velocity of sound in seawater?
(A) Increase in temperature, salinity, and depth (pressure)
(B) Decrease in temperature
(C) Decrease in depth
(D) Increase in turbidity

2013
237. Remote sensing in fisheries uses satellites equipped with sensors. Which type of sensor is capable of measuring Sea Surface Temperature (SST) even at night?
(A) Thermal infrared sensors
(B) Optical sensors
(C) Acoustic sensors
(D) Lidar

2005
238. Chlorophyll-a concentration is measured by satellites using Ocean Color sensors. What does a high concentration of chlorophyll-a indicate?
(A) High phytoplankton abundance (primary productivity)
(B) High salinity
(C) Heavy oil pollution
(D) Shallow bathymetry

2025
239. A thermal front identified on an SST satellite map is an area characterized by:
(A) A sharp gradient or boundary between two different water masses
(B) Uniform, unchanging temperatures
(C) Complete freezing of the sea surface
(D) Underwater volcanic activity

2001
240. Why do pelagic fish species, such as tuna and mackerel, tend to aggregate near oceanic thermal fronts and upwelling zones?
(A) Because these zones represent areas of high biological productivity and prey concentration
(B) Because these zones have lower salinity
(C) Because they are fleeing from predators
(D) Because the water is calmer there

2015
241. Global Positioning Systems (GPS) provide position data. To achieve an exceptionally high accuracy (within a few meters or less), what advanced system augments standard GPS?
(A) Differential GPS (DGPS)
(B) AIS
(C) RADAR
(D) VHF Direction Finder

2007
242. A typical marine RADAR operates in the microwave frequency band. Which band is preferred for better resolution of small targets (like buoys and small boats) at shorter ranges?
(A) X-band ($9 GHz$)
(B) S-band ($3 GHz$)
(C) L-band ($1 GHz$)
(D) C-band ($5 GHz$)

2001
243. In RADAR operations, what phenomenon causes "sea clutter" on the display?
(A) Reflections of the radar wave from the sea surface (waves) near the vessel
(B) Interference from other ships' radios
(C) Flocks of birds flying high
(D) Deep-sea submarines

2003
244. What defines an EPIRB (Emergency Position Indicating Radio Beacon)?
(A) A satellite-linked beacon used to transmit a distress alert and location to search and rescue authorities
(B) A beacon that transmits only to vessels within 5 miles
(C) A flashing light on a lifebuoy
(D) A sonar device for finding lost gear

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propeller to generate high thrust (bollard pull)
(B) Maximize propeller cavitation
(C) Decrease the overall weight of the vessel
(D) Make the boat go in reverse faster

2011
268. Cavitation on a marine propeller is caused by:
(A) The formation and violent collapse of low-pressure vapor bubbles on the blade surface, causing pitting
(B) High water temperature
(C) Excessive antifouling paint
(D) Striking submerged rocks

2003
269. The pitch of a propeller is defined as:
(A) The theoretical forward distance the propeller would advance in one complete revolution if moving through a solid medium
(B) The physical diameter of the blades
(C) The angle of the vessel's bow
(D) The total weight of the propeller hub

2022
270. Which of the following combinations of properties is correct for Controllable Pitch Propellers (CPP) often used on large trawlers?
I. The pitch angle of the blades can be adjusted dynamically.
II. They allow seamless shifting from forward to reverse without changing engine rotation.
III. They are cheaper and simpler to maintain than Fixed Pitch Propellers.
(A) I and II
(B) I and III
(C) II and III
(D) I, II and III

2024
271. In naval architecture, Simpson's Rules are mathematical formulas used primarily to calculate:
(A) The areas of waterplanes and volumes of irregular ship hulls
(B) The exact breaking strength of ropes
(C) The voltage required for cathodic protection
(D) The frequency of an echo sounder

2023
272. A vessel's Plimsoll line or load line mark indicates:
(A) The maximum legal draft to which the vessel can be safely loaded
(B) The location of the fuel tanks
(C) The center of gravity
(D) The length of the keel

2017
273. Free surface effect can be significantly reduced in fish holds by installing:
(A) Longitudinal wash bulkheads (baffle plates) or pound boards
(B) Thicker hull plates
(C) Larger scuppers
(D) Heavier anchors

2003
274. In the history of Indian fisheries, the Blue Revolution heavily emphasized:
(A) The rapid mechanization of fleets and expansion of aquaculture to boost production
(B) Banning all marine fishing operations
(C) The exclusive use of traditional wooden crafts
(D) The export of live marine mammals

2015
275. What represents a major disadvantage of synthetic netting materials?
(A) They are non-biodegradable and contribute persistently to marine microplastics.
(B) They decompose rapidly in salt water.
(C) They are impossible to knot manually.
(D) They sink instantly regardless of density.

2024
276. Which knot is traditionally used to attach a line securely to a spar, post, or the headline of a net without it slipping along the rope?
(A) Clove hitch
(B) Square knot
(C) Bowline
(D) Figure-eight knot

2013
277. A Dan leno is a specialized piece of equipment used in which type of gear?
(A) Trawl (connecting the sweep line to the wing ends)
(B) Longline
(C) Purse seine
(D) Trap

2018
278. In a trawl net, what is a flapper?
(A) A funnel or valve of netting placed inside the codend to prevent fish from swimming back out
(B) A piece of canvas used for signaling
(C) A float attached to the headrope
(D) A heavy chain on the footrope

NODIA

(B) Air pollution
(C) Noise pollution
(D) Thermal pollution

2003

257. An artisanal fish landing center differs from a major fishing harbor primarily in that it:
(A) Provides basic facilities (e.g., small shed, beach landing) mostly for motorized traditional and small mechanized crafts
(B) Accommodates ships over 100 meters
(C) Possesses a massive rubble-mound breakwater
(D) Has deep-water dry docks

2004

258. Dredging of the harbor basin and approach channel is periodically required to:
(A) Maintain the advertised navigational depth by removing accumulated sediment
(B) Catch benthic fish
(C) Build artificial reefs
(D) Increase water temperature

2019

259. What structural parameter distinguishes a jetty from a quay?
(A) A jetty projects out from the shore into the water, whereas a quay is built parallel to the shoreline.
(B) A quay is made of wood; a jetty is made of concrete.
(C) A quay is floating; a jetty is fixed.
(D) A jetty is only used for walking; a quay is used for berthing.

2008

260. Which operational phase in fishing dictates the size and capacity of the ice plant required at a harbor?
(A) The rate of fish landings and the requirement to maintain the catch below $4^{\circ}C$ during transportation and storage
(B) The time spent steaming to the grounds
(C) The speed of the net hauler
(D) The fuel capacity of the vessels

2015

261. Trawl nets are typically constructed from multiple panels. What are the names of the main body panels of a standard two-seam bottom trawl?
(A) Top (square/belly) and Bottom (belly) panels
(B) Port and Starboard panels
(C) Front and Back panels
(D) Inner and Outer panels

2011

262. The overhang or square in a bottom trawl is a section of netting projecting forward from the top panel. Its primary function is to:
(A) Prevent upward escape of fish disturbed by the footrope
(B) Increase the weight of the net
(C) Filter out sand and mud
(D) Provide buoyancy

2014

263. Identify the INCORRECT statement regarding deep-sea longlining.
(A) It is a highly active, high-speed towing gear.
(B) It targets high-value pelagic species like tuna and swordfish.
(C) The mainline can be tens of kilometers long.
(D) Hooks are deployed at specific depths using floats and weights.

2013

264. Identify the correct pair regarding net construction terminology.
(A) Bar cut - Cutting diagonally across the mesh, breaking one knot at a time
(B) Point cut - Cutting along the knots parallel to the vertical axis of the mesh
(C) Mesh size - The diameter of the twine used
(D) Selvage - The weakest part of the net

2014

265. What makes Monel metal (a nickel-copper alloy) useful in certain marine fittings despite its high cost?
(A) It possesses extreme resistance to corrosion and biofouling.
(B) It is lighter than aluminum.
(C) It is completely transparent.
(D) It dissolves harmlessly in water.

2019

266. A typical marine propulsion system couples the engine to the propeller via a:
(A) Marine gearbox (reduction gear)
(B) Winch drum
(C) PTO shaft only
(D) Universal joint

2024

267. The reduction ratio of a marine gearbox in a trawler allows the engine to run at high RPM while the propeller turns at a lower RPM. This is done to:
(A) Allow the use of a larger, more efficient

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2019

245. An SART (Search and Rescue Transponder) assists in locating survival craft by:
(A) Showing a series of dots on an approaching vessel's 9 GHz (X-band) RADAR display
(B) Emitting a loud siren
(C) Broadcasting a voice message on VHF Channel 16
(D) Sending an SMS to the coast guard

2011

246. VHF Channel 16 is internationally reserved for:
(A) Distress, safety, and calling communication
(B) Routine inter-ship weather updates
(C) Private conversations between fishers
(D) Broadcasting commercial radio stations

2017

247. The introduction of GMDSS (Global Maritime Distress and Safety System) automated safety communications. Under GMDSS, which device allows for instant, digital transmission of a distress alert at the push of a button?
(A) Digital Selective Calling (DSC)
(B) Navtex
(C) Public Address System
(D) Aldis lamp

2008

248. Fishing harbors are generally categorized by their depth and infrastructure. A deep-sea fishing harbor is designed to accommodate:
(A) Large industrial vessels requiring significant draft (e.g., $>$ 5 meters) and extensive shore facilities
(B) Only traditional non-motorized crafts
(C) Exclusively inland riverine boats
(D) Amphibious vehicles

2015

249. A rubble-mound breakwater is constructed using:
(A) A core of smaller rocks protected by increasingly larger armor stones or concrete units on the outside
(B) Interlocking plastic blocks
(C) Solid poured concrete walls only
(D) Wooden piles driven into the sand

2008

250. The Tetrapod and Accropode are examples of:
(A) Artificial concrete armor units used in breakwater construction to interlock and dissipate wave energy
(B) Modern fishing vessels
(C) Deep-sea fishing gear
(D) Electronic navigation devices

2004

251. Inside a fishing harbor, an auction hall must strictly adhere to hygiene standards. Which of the following is a mandatory design feature for a modern hygienic auction hall?
(A) Sloping, smooth concrete/epoxy floors with adequate drainage and pressurized wash-down systems
(B) Porous wooden floors
(C) Open, sunlit roofs with no shade
(D) Dirt or sand flooring

2012

252. The draft of a fishing vessel restricts its ability to enter certain harbors. What natural phenomenon must a skipper carefully monitor when approaching a shallow harbor entrance?
(A) The phase of the moon to predict tidal height (high tide vs. low tide)
(B) The atmospheric pressure
(C) The ambient air temperature
(D) The salinity of the estuary

2009

253. In harbor infrastructure, what is a floating pontoon?
(A) A buoyant platform that rises and falls with the tide, used for safe berthing of small crafts
(B) A stationary concrete wall
(C) A dry dock
(D) A navigational beacon

2019

254. A dry dock is specifically utilized for:
(A) Lifting or draining a vessel out of the water to inspect and repair the underwater hull and propulsion systems
(B) Storing dried fish
(C) Berthing vessels during normal loading operations
(D) Building new nets

2006

255. Bunkering facilities in a fishing harbor provide what essential service to the vessels?
(A) Marine diesel oil and lubricants
(B) Ice and fresh water
(C) Net repair materials
(D) Crew accommodation

NODIA

2012

256. What environmental concern is primarily mitigated by installing oil spill booms and waste reception facilities in a fishing harbor?
(A) Marine water pollution from oily bilge discharges and accidental spills

2001
279. Chafing gear is attached to the underside of a trawl codend primarily to:
(A) Protect the actual codend netting from abrasive wear against the seabed
(B) Frighten away sharks
(C) Provide additional buoyancy
(D) Measure the temperature of the mud

2021
280. The most appropriate definition of fishing effort is:
(A) A measure of the amount of fishing gear of a specific type used on the fishing grounds over a given unit of time
(B) The physical strength of the crew
(C) The total weight of fish landed
(D) The fuel consumed during steaming

2010
281. Catch Per Unit Effort (CPUE) is widely used by fisheries scientists as an index of:
(A) Relative abundance or biomass of the target fish stock
(B) Vessel speed
(C) Market price of fish
(D) The amount of netting used

2017
282. In gear selectivity studies, the $L_{\{50\}}$ (50% retention length) represents:
(A) The length at which 50% of the fish encountering the gear are retained
(B) The maximum length of the net
(C) The depth of the water
(D) The age of the fish

2019
283. What curve shape is typical for the selection curve of a trawl net codend?
(A) Sigmoidal (S-shaped / logistic curve)
(B) Bell-shaped (Gaussian)
(C) Linear, downward sloping
(D) Exponential decay

2003
284. The selection curve for a gillnet differs from a trawl codend because it is heavily dependent on the fish matching the mesh size. What shape is a gillnet selection curve typically?
(A) Perfectly square
(B) Bell-shaped (unimodal or bimodal)
(C) Vertically elongated diamond
(D) Horizontally elongated diamond

2018
285. A marine engine's cooling system often uses a heat exchanger. What is the purpose of this component?
(A) To cool the closed-circuit fresh water of the engine block using outside seawater
(B) To mix engine oil with seawater
(C) To heat the crew cabins
(D) To boil seawater for drinking

2012
286. What is the function of a stuffing box (or stern tube seal) on a motorized fishing vessel?
(A) To prevent seawater from entering the hull where the propeller shaft exits
(B) To store emergency food rations
(C) To pack the caught fish tightly
(D) To muffle the exhaust sound

2017
287. Which method is most relevant for assessing the breaking strength of a synthetic twine?
(A) Tensile testing machine (dynamometer)
(B) Spectrophotometry
(C) Acoustic ranging
(D) Thermal imaging

2002
288. The stretch of a synthetic twine under load consists of two components. Which of the following defines them?
(A) Elastic (recoverable) stretch and plastic (permanent) elongation
(B) Viscous and liquid stretch
(C) Static and dynamic stretch
(D) Heavy and light stretch

2016
289. Consider the following operational features of acoustic pingers used for by-catch mitigation:
I. They emit low-frequency sounds mimicking predators.
II. They emit high-frequency ultrasonic clicks.
III. They are attached at regular intervals along the gillnet headrope.
IV. They alert cetaceans to the presence of the invisible net barrier.
V. They instantly kill all marine mammals nearby.
Which of the above statement(s) is/are correct?
(A) I, II, III and V
(B) II, III and IV
(C) I, III, IV and V
(D) I, II, IV and V

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21. (B) Delamination
Repeated mechanical flexing and dynamic loading of a fiberglass reinforced plastic hull over time can cause the individual layers of glass fiber and resin to separate. This failure mechanism, known as delamination, severely compromises the structural integrity of the hull and can lead to water intrusion and complete structural failure if left untreated.

22. (C) Carvel build
Carvel construction is a traditional wooden boat building method where hull planks are laid edge-to-edge over solid frames to create a smooth outer surface. The narrow seams between the flush-fitting planks are then packed with caulking materials and sealed to ensure the hull remains completely watertight during operation at sea.

23. (D) Tributyltin (TBT)
Tributyltin was an extremely effective biocide used in marine anti-fouling paints to prevent the growth of barnacles and algae. However, it was globally banned due to its high toxicity to non-target organisms, causing severe endocrine disruption and imposex, the development of male characteristics in female marine gastropods, at extremely low concentrations.

24. (A) Cathodic protection with sacrificial anodes
Cathodic protection involves attaching sacrificial anodes made of highly active metals, like zinc or aluminum, directly to a steel hull. Because these anodes have a lower electrochemical potential than steel, they corrode preferentially, supplying electrons to the hull and effectively protecting the structural steel from electrochemical oxidation and decay.

25. (B) Creosote is highly effective against borers but cannot be painted over.
Creosote is a highly effective oil-borne wood preservative traditionally used to protect marine timbers from destructive boring organisms and decay. While it provides long-lasting protection in harsh aquatic environments, its oily, tar-like nature bleeds through finishes, preventing the application of standard paints or varnishes on the treated wood surface.

26. (B) Direct electrical current
Impressed current cathodic protection systems protect a vessel's hull from corrosion by actively supplying a controlled direct electrical current from an onboard power source to dedicated inert anodes. This current neutralizes the natural electrochemical corrosive currents generated on the steel hull, providing constant, adjustable protection without relying solely on sacrificial zinc blocks.

27. (A) Increased drag and higher fuel consumption
The accumulation of marine organisms like barnacles and algae on a vessel's hull significantly increases surface roughness and hydrodynamic drag. This increased resistance forces the engine to work much harder to maintain speed, resulting in a substantial rise in fuel consumption and overall operational costs for the fishing vessel.

28. (C) Zinc
Zinc is the most common material chosen for sacrificial anodes on vessels operating primarily in saltwater because of its highly reliable galvanic properties. In highly conductive saltwater, zinc corrodes easily and predictably, releasing electrons that protect critical steel structures, propellers, and shafts from electrochemical decay and pitting.

29. (D) Controlled release of toxic ions to deter growth
Copper-based anti-fouling paints function by steadily leaching cuprous ions into the boundary layer of water immediately surrounding the vessel's hull. This controlled release of copper ions creates a toxic micro-environment that prevents the settlement and growth of larval barnacles, mollusc shells, and algal spores on the underwater surface.

NODIA

30. (A) I and II
Wooden hulls are traditionally protected using physical barriers like copper sheathing to block marine borers and chemical preservatives like creosote to prevent wood rot. Spraying wooden structures with highly corrosive hydrochloric acid is not a protective method, as it actively degrades the natural cellulose fibers of the timber.

31. (B) Barrier coat isolating steel from seawater
Applying a high-quality primer coat to a steel hull is essential to create an impermeable barrier that completely isolates the metal from moisture and dissolved oxygen. This protective layer prevents the electrochemical reactions that cause rust,

initial static stability
2. The point through which the upward force of displaced water acts
3. The point of intersection of the vertical lines through the center of buoyancy when upright and when heeled
4. The point through which the total downward weight of the vessel acts

(A) P-4, Q-2, R-1, S-3
(B) P-4, Q-2, R-3, S-1
(C) P-2, Q-4, R-1, S-3
(D) P-3, Q-1, R-4, S-2

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NODIA

ANSWERS

1. (A) Flat bottom hull
Flat bottom hull designs are simple to construct and offer excellent initial stability in calm waters due to their flat underwater profile. However, when operating in rough or choppy seas, they tend to pound heavily against oncoming waves, resulting in a very rough ride and significant structural stress on the vessel's hull.

2. (C) Camber
Camber represents the slight transverse curvature or slope given to the deck of a vessel, rising from the sides toward the centerline. This structural feature ensures that water washing onto the deck from rain or spray drains quickly to the sides and overboard, preventing accumulation and maintaining a dry, safe working environment.

3. (A) Buoyancy
The center of buoyancy is the geometric center of the underwater volume of a vessel, representing the specific point through which the total upward buoyant force acts. This point shifts dynamically as the vessel heels or trims, directly influencing the righting lever and the overall static stability of the craft in water.

4. (D) Buoyancy force acts downward against the hull.
Archimedes' principle dictates that the upward buoyant force acting on a floating vessel is exactly equal to the weight of the water displaced by its hull. This physical force acts in a vertical upward direction, opposing gravity, which acts downward, thereby allowing the vessel to remain afloat in a state of stable static equilibrium.

5. (B) Freeboard
Freeboard is defined as the vertical distance from the waterline of a vessel to the upper edge of its working deck. This parameter is critical for maintaining reserve buoyancy and preventing seawater from washing over the deck, thereby ensuring the safety and stability of the vessel under various loading and sea conditions.

6. (C) Keel
The keel serves as the primary structural backbone of a vessel, running longitudinally along the centerline of the bottom. It provides essential longitudinal strength, prevents twisting of the hull, and acts as the central anchor to which the ribs, frames, and stem are attached, distributing structural loads evenly across the entire vessel.

7. (D) Dynamic lift
Planing hulls are designed to rise above the water surface at high speeds by utilizing dynamic lift generated by the flow of water against the bottom. This upward force reduces the wetted surface area and hydrodynamic resistance, allowing the vessel to achieve much higher speeds than conventional displacement hulls of similar power and size.

8. (A) Righting moment
The righting moment of a vessel is the torque generated by the horizontal separation between the center of gravity and the center of buoyancy when heeled. This restoring force acts to return the vessel back to its original upright position, serving as a fundamental measure of the craft's transverse stability and seaworthiness.

9. (B) They offer lower resistance and smoother motion in a seaway.
Round bilge hulls lack sharp corners along the bottom sides, which significantly reduces wave-making resistance and friction during operation. This hydrodynamic shape provides exceptionally smooth motion and excellent comfort in rough open ocean waters, making it highly desirable for offshore fishing vessels that must endure prolonged voyages in challenging sea states.

10. (A) Both A and R are true and R is the correct explanation of A.
Lowering the center of gravity increases the vertical distance to the metacenter, which directly expands the metacentric height of a vessel. A larger metacentric height generates a stronger righting moment at small angles of heel, thereby providing much greater initial stability and ensuring the vessel quickly returns to its upright position when disturbed.

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11. (A) Block coefficient
The block coefficient is a dimensionless ratio that compares the actual underwater volume of a vessel to the volume of a rectangular block with identical length, breadth, and draft. It indicates the fullness of the hull form, with lower values representing slender, fast designs and higher values representing full, high-capacity cargo vessels.

12. (C) It will become loll and float at an angle.
A negative metacentric height means the center of gravity lies above the metacenter, creating an unstable upright equilibrium. Consequently, the vessel cannot remain upright and will heel over to one side until the underwater hull shape shifts the center of buoyancy enough to establish a stable angle of loll, risking capsizing.

13. (D) Marine wood
Marine wood has been favored for small-scale boat building due to its natural buoyancy, flexible properties, and ease of working with simple hand tools. Despite these benefits, wooden vessels demand intensive, regular maintenance to protect the timber from marine boring organisms, rot, and moisture absorption, which degrade the structural integrity over time.

14. (C) Ongoing needs for surface corrosion protection
Steel is highly susceptible to rust and oxidation when exposed to harsh saltwater environments, which rapidly degrades its structural integrity. Constructing small fishing vessels with steel requires constant, costly surface preparation, painting, and maintenance of sacrificial anodes, unlike fiberglass reinforced plastic, which is highly resistant to marine corrosion and requires far less upkeep.

15. (B) Higher strength-to-weight ratio and resistance
Aluminum offers an exceptionally high strength-to-weight ratio, allowing the construction of lightweight boat hulls that retain high structural integrity and durability. This reduction in structural weight translates directly into higher fuel efficiency, greater cargo-carrying capacity, and increased speed, while the material naturally resists atmospheric and seawater corrosion when properly insulated.

16. (D) Steel wire mesh armature and rich cement mortar
Ferro-cement boat construction involves plastering a highly dense armature made of steel wire mesh and reinforcing rods with a rich, specialized cement mortar. This composite structure is highly economical for heavy displacement hulls, providing a durable, fire-resistant, and easily repairable hull without requiring highly specialized shipyard machinery or expensive molding equipment.

17. (A) Wood - Isotropic material with uniform strength in all directions
Wood is an anisotropic material because its physical properties and mechanical strength vary significantly depending on the direction of the grain. It exhibits high tensile and compressive strength parallel to the grain, but is relatively weak perpendicular to it, unlike isotropic materials like steel or aluminum which maintain uniform properties in all directions.

18. (C) A polymer resin matrix and glass fiber reinforcement
Fiberglass Reinforced Plastic is a composite material composed of strong glass fibers embedded within a liquid polymer resin matrix. The glass fibers provide high tensile strength and structural reinforcement, while the resin cures to bind the fibers together, distributing mechanical loads and protecting them from environmental degradation and moisture absorption.

NODIA

19. (A) Smooth, protective, and water-resistant finish
Gelcoat is a specialized high-quality polyester resin applied to the outer surface of a fiberglass reinforced plastic hull during the molding process. It cures to form a smooth, cosmetically appealing, and highly water-resistant barrier that protects the underlying structural glass fibers from osmotic blistering, ultraviolet degradation, and mechanical wear.

20. (A) P-2, Q-4, R-1, S-3
Marine wood is vulnerable to boring organisms. Steel provides the highest impact resistance for heavy fishing. Aluminum requires zinc anodes to prevent galvanic corrosion when paired with other metals in water. Ferro-cement remains a highly economical choice for building heavy, low-cost displacement hulls in developing coastal regions.

2013

290. Which component of total hull resistance is primarily caused by the friction of water against the vessel's wetted surface area?
(A) Wave-making resistance
(B) Frictional resistance
(C) Eddy-making resistance
(D) Air resistance

2021

291. What is the primary cause of osmosis in older fiberglass (FRP) boat hulls?
(A) Water molecules penetrating the gelcoat and reacting with un-cured resin chemicals to form blistering acidic fluid
(B) Direct sunlight fading the gelcoat
(C) Electromechanical corrosion from zinc anodes
(D) Bacterial digestion of the glass fibers

2018

292. When designing a fishing harbor, an important parameter is the turning basin. What is its function?
(A) A wide, sufficiently deep area of water within the harbor allowing vessels to safely turn around
(B) An area for fish processing
(C) A rotating crane for lifting cargo
(D) The central point of the compass rose

2025

293. An Ice plant produces different forms of ice. Which form is considered best for packing fragile pelagic fish due to its lack of sharp edges?
(A) Flake ice or Slurry ice
(B) Block ice
(C) Tube ice
(D) Dry ice

2024

294. Identify the INCORRECT statement regarding the handling of marine pyrotechnics.
(A) Expired flares can be safely disposed of by tossing them in the harbor water.
(B) They should be stored in a cool, dry, and easily accessible watertight container.
(C) They should only be used in genuine distress situations.
(D) Instructions are typically printed directly on the casing.

2006

295. Which component of a marine VHF radio system dictates the effective range of communication?
(A) The height and line-of-sight clearance of the antenna
(B) The volume knob setting
(C) The color of the handset
(D) The temperature of the cabin

2018

296. A bollard on a harbor quay is designed to:
(A) Anchor the mooring lines (hawsers) of a vessel securely to the dock
(B) Provide night illumination
(C) Supply fresh water to the vessel
(D) Weigh the landed fish

2012

297. Which of the following fishing gears is known to have the highest rate of completely unselective catching and massive habitat destruction when used illegally?
(A) Dynamite (blast fishing)
(B) Handlines
(C) Cast nets
(D) Pole-and-line

2012

298. Consider the following statements regarding deep-sea squid jigging:
Assertion (A): Deep-sea squid jigging is conducted at night using intense artificial lighting.
Reason (R): Squids exhibit strong positive phototaxis, causing them to aggregate in the illuminated zone around the vessel.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2012

299. In the context of fishing vessel design, what does the abbreviation "OAL" stand for?
(A) Overall Length
(B) Ocean Assessment Limit
(C) Operational Acoustic Level
(D) Optimal Anchor Load

2024

300. Consider the following terms related to vessel stability and their definitions:
List I: (Stability Term)
P. Center of Gravity (G)
Q. Center of Buoyancy (B)
R. Metacenter (M)
S. Metacentric Height (GM)
List II: (Definition)
1. The distance between G and M, indicating

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while providing a highly compatible surface for the subsequent adhesion of anti-fouling topcoats.

32. (D) Polyethylene (PE)
Polyethylene has a specific gravity of approximately 0.95 to 0.96, which is lower than that of both fresh and saltwater. Consequently, this synthetic polymer floats naturally, making it highly useful for manufacturing fishing net components, floats, and ropes that need to maintain buoyancy without absorbing water or losing strength.

33. (A) Polyester (PES)
Polyester is a synthetic polymer characterized by outstanding resistance to ultraviolet radiation, high tensile strength, and very low elastic stretch under heavy loads. These material properties make it exceptionally suited for manufacturing high-tension pelagic trawl warps, longlines, and rigging that must withstand prolonged exposure to sunlight and harsh marine conditions.

34. (C) It loses 10-20% of its tensile strength.
Polyamide, commonly known as nylon, is highly hygroscopic and absorbs water when submerged. This absorption of water molecules temporarily weakens the internal hydrogen bonds between the polymer chains, resulting in a ten to twenty percent loss of its dry tensile strength, along with a slight increase in elasticity and overall length.

35. (A) Susceptibility to bacterial and fungal rotting
Natural fibers such as cotton and manila consist of cellulose or proteins, which serve as nutrients for marine microorganisms. When submerged or kept damp, these fibers are quickly attacked by cellulose-digesting bacteria and fungi, leading to rapid rotting, structural degradation, and a severe loss of breaking strength compared to synthetic fibers.

36. (D) Polyamide
Polyamide exhibits a high melting point, typically ranging between 215 and 260 degrees Celsius depending on the specific polymer type. This high thermal threshold surpasses other common netting materials like polyethylene and polypropylene, ensuring that nylon netting maintains its structural integrity and resists melting under localized frictional heat during high-speed net operations.

NODIA

37. (B) Multifilaments are made by twisting multiple fine continuous filaments together.
Multifilament yarns are constructed by twisting together numerous ultra-fine, continuous synthetic filaments to form a single flexible twine. This design contrasts with monofilament yarns, which consist of a single thick, solid extruded strand, providing multifilament netting with superior flexibility, high knot holding security, and ease of handling during commercial fishing operations.

38. (C) Direct system
A direct yarn numbering system defines the size of a yarn based on its mass per unit length. In these systems, such as Tex or Denier, a larger number corresponds directly to a heavier and thicker twine, making it highly intuitive for comparing the weight and physical size of various synthetic netting materials.

39. (B) 1,000 meters
The Tex system is an international direct yarn numbering system defined as the mass in grams of exactly one thousand meters of yarn. This standardized unit allows direct comparison across different material types, where a higher Tex value indicates a thicker, heavier yarn, streamlining calculations for net weight and overall structural design.

40. (A) I, II and IV
Denier measures mass per nine thousand meters, metric count represents length per unit mass, and runnage indicates length per unit weight. Tex is a direct numbering system, not an indirect one, because it is based on the mass per unit length, specifically the weight in grams of one thousand meters of yarn.

41. (B) Z-twist
A twine is designated as having a Z-twist when its constituent fibers or strands spiral upward to the right, aligning with the central diagonal slope of the letter Z. This twist direction is standard in textile and net-making industries, providing structural balance when combined with S-twisted components in subsequent stages.

42. (B) S → Z → S
To produce a balanced and stable fishing twine, the direction of the twist must alternate at each stage of the manufacturing process. Starting with S-twisted single yarns, the fibers are

64. (D) Shift from subsistence fishing to commercial, export-oriented shrimp trawling
The mechanization phase of the 1960s and 70s dramatically transformed Indian fisheries by shifting focus from localized subsistence harvesting to highly lucrative, export-oriented shrimp trawling. This transition stimulated the growth of processing infrastructure, ice plants, and freezing facilities, while attracting significant commercial investment to coastal states.

65. (A) To drive auxiliary deck machinery like winches from the main engine
Power take-off systems are mechanical devices that transmit rotational power directly from the main marine diesel engine to auxiliary deck equipment. This system drives hydraulic pumps, trawl winches, net haulers, and alternators, eliminating the need for separate auxiliary engines and maximizing the overall mechanical efficiency of the vessel.

66. (C) Immersion suit
An immersion suit is a specialized protective dry suit designed to reduce heat loss and prevent hypothermia when a crew member is immersed in cold water. Classified as a personal Lifesaving Appliance, it must be highly visible, buoyant, and capable of keeping a survivor warm during emergency abandonment of a vessel.

67. (A) Inflatable liferafts
A hydrostatic release unit is an essential safety device designed to automatically deploy inflatable liferafts if a vessel sinks. When the unit reaches a depth of two to four meters, water pressure activates a cutting mechanism that releases the liferaft canister, allowing it to float free and inflate on the surface.

68. (D) Smoke signals are highly effective for nighttime distress alerts.
Orange smoke signals are designed specifically for daytime use because the dense, brightly colored smoke is highly visible against the water under sunlight, helping rescue aircraft locate survivors. At night, smoke is virtually invisible, making burning pyrotechnic flares, such as hand-held or parachute flares, the mandatory choice for signaling.

69. (B) Class B and C (Flammable liquids and electrical fires)
Carbon dioxide extinguishers are highly effective for fighting Class B fires involving flammable liquids and Class C electrical fires. The non-conductive gas displaces oxygen to smother the flames rapidly without leaving any chemical residue, which prevents damage to sensitive electronic navigation equipment and machinery on board the vessel.

70. (A) Throw canister overboard → Pull painter line fully to inflate → Board liferaft → Cut painter line
In an emergency, the liferaft canister is thrown overboard while securing the painter line to the vessel. Pulling the painter line fully triggers the inflation mechanism. Once the raft is inflated, the crew boards it directly, and the painter line is cut using the safety knife to safely drift away from the sinking vessel.

71. (D) Cospas-Sarsat satellite system
An Emergency Position Indicating Radio Beacon is designed to transmit a digital distress signal on the international emergency frequency of 406 megahertz. This signal is detected by the global Cospas-Sarsat satellite system, which forwards the vessel's unique identification and precise coordinates to rescue coordination centers worldwide.

72. (A) Lifebuoys
Lifebuoys must be painted in highly visible international orange to ensure they can be easily spotted by search and rescue teams in rough seas or low visibility. This striking color contrast against the blue or grey ocean surface is a mandatory safety standard defined by international maritime conventions.

73. (B) A continuous flashing blue strobe light
International regulations for preventing collisions at sea specify visual distress signals including a square flag with a ball, a continuous foghorn, or flames on a vessel. A flashing blue strobe light is not a recognized distress signal, as flashing blue lights are reserved for law enforcement, customs, or security vessels.

74. (B) Purse seine
Under the FAO gear classification, a purse seine is categorized as a surrounding net because it is designed to encircle a school of pelagic fish from

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design is exceptionally suited for launching and landing through the heavy, surf-beaten beaches along the East Coast of India.

54. (C) Hollowing out a single large log of wood
The traditional dugout canoe is constructed by meticulously hollowing out a single large, solid log of wood, such as mango or junglejack. This robust, seamless hull design has been utilized for centuries along the southwest coast of India, providing artisanal fishers with a durable, highly stable craft for nearshore operations.

55. (D) Planks are sewn together using coir ropes without rigid internal framing.
Stitched boats, such as the Masula boat, are constructed by sewing wooden planks together edge-to-edge using flexible coir ropes, with the seams packed with straw or hay for water tightness. This lack of rigid internal framing allows the hull to flex and absorb the heavy impacts of breaking surf without breaking.

56. (A) Motorized traditional craft (e.g., Vallam with OBM)
The motorized traditional craft represents a key technological step in Indian fisheries, where outboard motors are fitted to traditional wooden or fiberglass hulls like Vallams. This modification allows artisanal fishers to reach distant fishing grounds quickly and return with fresh catch, significantly reducing manual labor without requiring expensive mechanized vessels.

57. (B) Tamil Nadu
The Teppa or Kattumaram is a traditional log raft widely operated by artisanal fishers along the surf-beaten coast of Tamil Nadu. Composed of light, buoyant logs lashed together, this simple yet robust craft is designed to easily ride over heavy beach surf where conventional rigid boats would capsize or break apart.

58. (B) Broad beam, deep draft, and a heavy wooden keel for stability in rough seas
Plank-built boats of the northwest coast of India, like the Satpati, were designed with a broad beam, a deep draft, and a heavy wooden keel. This robust construction provides exceptional stability, high carrying capacity, and strong seaworthiness, allowing fishers to operate safely in the turbulent offshore waters of the Arabian Sea.

59. (A) Outrigger canoe
Outrigger canoes use a secondary float, or outrigger, attached parallel to the main hull by supporting beams, or a balance board extending to windward. This configuration dramatically increases the transverse stability of the narrow hull, preventing capsizing under sail or in rough, rolling coastal waters while maintaining a lightweight profile.

60. (C) Dugout canoes → Stitched boats → Motorized traditional crafts → Mechanized trawlers
The historical evolution of fishing crafts in India progressed from simple dugout canoes carved from single logs, to stitched plank boats like the Masula, followed by the motorization of traditional vessels with outboard engines, and finally the adoption of purpose-built mechanized trawlers powered by inboard diesel engines.

61. (D) Mechanized wooden boats and bottom trawling techniques
The Indo-Norwegian Project, established in 1952, revolutionized the Indian marine fisheries sector. It introduced standardized mechanized wooden boats, modern marine diesel engines, and efficient bottom trawling techniques, paving the way for commercial shrimp exploitation and modernizing the design of small-scale fishing vessels across the country.

62. (C) Kerala
Kerala served as the initial operational base for the Indo-Norwegian Project, centered around the fishing villages of Neendakara and Sakthikulangara. The project focused on motorizing local boats, constructing ice plants, and training local fishers in mechanized trawling, which catalyzed the development of modern commercial fishing in the state.

63. (B) FAO
The Food and Agriculture Organization actively collaborated with the Indo-Norwegian Project to promote the mechanization of Indian fishing fleets. FAO naval architects designed efficient, standardized wooden hull profiles equipped with inboard diesel engines, helping transition the artisanal sector away from pure sail and oar propulsion toward modern motorized operations.

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phototactic squids and their prey to the shadow boundary beneath the boat, where they are captured using automated mechanical jigging machines.

87. (D) By the balance of floats on the headline and weights/depressors on the footrope, combined with towing speed
In pelagic trawling, the vertical opening of the net is achieved without bottom contact. It relies on the balance between upward buoyant forces from floats on the headline and downward gravitational forces from weights or depressors on the footrope, which are dynamically adjusted by controlling the towing speed of the vessel.

88. (A) Net-sonde
A net-sonde is a specialized acoustic sensor mounted directly on the headline of a mid-water trawl. It transmits real-time sonar data back to the vessel, showing the exact depth of the net, its vertical opening, the distance to the seabed, and schools of fish entering the mouth of the net.

89. (B) Line hauler
A line hauler is a mechanized deck device equipped with a rotating, grooved sheave designed to haul the heavy mainline of a longline system back onto the vessel. This equipment reduces physical labor, allowing crews to retrieve kilometers of mainline and hundreds of hooks efficiently and safely.

90. (A) P-2, Q-3, R-4, S-1
Tuna longlining targets deep-swimming pelagics. Mid-water trawling captures schooling krill or fish. Squid jigging relies on phototactic responses of cephalopods to intense surface lights. Purse seining is the primary commercial method used to surround and capture massive, dense surface schools of small pelagic fish like sardines and mackerel.

91. (A) Lack heavy ground gear (like rockhoppers) and have a larger mouth opening
Mid-water trawls operate in the water column without touching the seabed, allowing them to eliminate heavy bobbins or rockhopper gear. To intercept fast-swimming pelagic species, they are designed with a much larger mouth opening and lightweight netting, which reduces hydrodynamic drag compared to heavy bottom trawls.

92. (C) To provide horizontal spreading force to keep the net mouth open
Otter boards act as hydrofoils when towed through the water, generating a significant outward horizontal force. This spreading force pulls the towing warps apart, keeping the mouth of the bottom or mid-water trawl wide open transversely, which is essential for maximizing the swept area and catching efficiency.

93. (D) Rockhopper or bobbin gear
Rigging a bottom trawl with rockhopper or heavy bobbin gear along the footrope allows the net to roll over rough, rocky seabeds and obstacles without snagging. This heavy, rolling ground gear lifts the netting panel slightly above rocks, preventing costly tears and damage while maintaining close bottom contact.

94. (C) Winching in the purse line running through rings at the bottom to close the net
The process of pursing involves winching the purse line, which runs through metal purse rings suspended from the footrope of the net. Drawing this line tight closes the bottom of the purse seine like a drawstring bag, trapping the surrounded fish school and preventing them from escaping downward.

95. (B) Puretic power block
The Puretic power block revolutionized purse seining by automating the retrieval of heavy webbing. This large hydraulic V-grooved pulley, suspended from a boom, grips and hauls the net mechanically, dramatically reducing manual labor, shortening hauling times, and allowing vessels to handle much larger nets with smaller crews.

96. (D) Using massive, super-large meshes or parallel ropes in the front section
Incorporating very large meshes or parallel ropes in the wings and front sections of a trawl net drastically reduces hydrodynamic drag and fuel consumption. This design utilizes the herding behavior of fish, which actively swim away from the ropes toward the center of the net, leading them into the codend.

97. (B) 30° to 40°
The optimal angle of attack for standard otter boards typically lies between thirty and forty degrees. This range provides the most efficient balance, generating the maximum horizontal

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both the sides and the bottom. Once surrounded, the bottom of the net is closed, preventing the catch from escaping downward before hauling.

75. (A) The gear remains stationary and captures fish that move into it voluntarily.
Passive fishing methods rely on the targeted aquatic organisms moving voluntarily into a stationary gear, such as a gillnet, longline, trap, or pot. Because the gear does not require active towing, these methods consume very little fuel and generally yield high-quality fish with minimal physical damage to the catch.

76. (C) Mid-water trawl
A mid-water trawl is an active fishing gear because it must be towed through the water column by one or more vessels to capture pelagic fish. This active movement requires substantial engine power to overcome the hydrodynamic drag of the net, contrasting with passive gears that remain stationary in the water.

77. (D) Cast net
Cast nets are classified as falling gear in the FAO system because they are thrown over a specific water area and fall on top of the target fish. Weighted lines along the perimeter sink quickly, trapping the fish beneath the webbing, which is then secured as the net is hauled back.

78. (C) Benthic molluscs and scallops
Dredges are heavy, rigid metal frames equipped with a collecting bag made of steel rings or mesh. They are specifically designed and dragged along the seabed to target benthic molluscs, clams, and scallops, scraping them out of the sandy or muddy substrate where they naturally burrow.

79. (B) Surface drift nets and set gillnets
Inland reservoirs often contain submerged trees, rocks, and irregular bottom topography that make active towed gears like trawls unusable. Consequently, fishers rely on passive gears like surface drift nets and set gillnets, which remain stationary in the water column and capture fish by entangling or gilling them with minimal risk of snagging.

80. (A) Both A and R are true and R is the correct explanation of A.
Dragging heavy bottom trawls through fragile shallow estuaries and river mouths is heavily restricted because it causes severe destruction of benthic habitats. This destructive action scrapes the seabed, destroys seagrass and oyster beds, and kills juvenile fish and crustaceans that rely on these areas as critical nursery grounds.

81. (A) Inland rivers and reservoirs of southern India
The coracle is a lightweight, circular craft made of woven bamboo split frames covered with animal hides or plastic sheets. Extremely maneuverable and easy to transport, it is widely utilized for artisanal gillnetting and longlining in the calm waters of inland rivers, canals, and deep reservoirs throughout southern India.

82. (C) Stake net (Stow net)
Stake nets are specialized estuarine gears anchored to the seabed using long wooden or bamboo poles. They remain stationary and open, utilizing strong tidal currents to filter fish, shrimp, and other organisms directly into the bag. The catch is then harvested as the tide recedes and the current slackens.

83. (A) Tidal currents
The operation of a Dol net along the northwest coast of India is completely dependent on strong tidal currents. This massive bag net is fixed to the seabed using heavy anchors or stakes, relying on the force of incoming or outgoing tides to keep the net mouth wide open and filter passing fish.

84. (D) To guide migrating fish into a confined chamber where they cannot escape
In riverine environments, barrier traps are constructed across channels to intercept migrating fish. The structures use guiding walls made of webbing or bamboo to direct fish into a narrow, one-way entrance leading to a terminal holding chamber, where they are trapped safely without being damaged by heavy currents.

85. (B) Branch lines (snoods) and float lines
Oceanic tuna longlines are set to target specific swimming depths where water temperature and oxygen levels are optimal. This depth is controlled by adjusting the length of the vertical float lines that support the mainline, along with the length of the individual branch lines that carry the baited hooks.

86. (C) High-intensity artificial lighting
Commercial squid jigging operations utilize powerful overhead and underwater high-intensity lamps to illuminate the sea surface around the vessel at night. This light attracts schools of

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combined using a Z-twist in the second stage, and then finished with an S-twist, preventing the completed twine from spontaneously unlaying.

43. (A) It measures 840-yard hanks per pound of yarn
The English cotton count is classified as an indirect numbering system because it measures the length of yarn obtained from a unit weight, defined as the number of 840-yard hanks per pound. Consequently, higher count numbers indicate a finer, lighter yarn, while lower numbers represent a thicker and heavier material.

44. (C) Length of twine measured per unit weight
Runnage is an indirect measurement of twine thickness defined as the total length of twine produced per unit of weight, typically expressed in meters per kilogram. This parameter is highly practical for fishers and net manufacturers to calculate the quantity of twine needed to build or repair netting of specific dimensions.

45. (D) Sheet bend (weaver's knot)
The sheet bend, commonly known as the weaver's knot, is the standard knot utilized in commercial net making. It is highly resistant to slipping, even when tied using slick synthetic monofilament or multifilament twines, ensuring that the mesh dimensions remain stable and do not distort under the heavy tensions of fishing.

46. (C) Stretched distance between opposite knots
International fisheries regulations define mesh size as the internal distance between two opposite knots when the mesh is fully stretched along its longitudinal axis. This standardized measurement technique ensures consistency for enforcement, by-catch reduction audits, and scientific assessments of gear selectivity across different fleets and regional management zones.

47. (B) Length of the mounting rope divided by the length of the stretched netting
The hanging ratio is the mathematical relationship calculated by dividing the physical length of the supporting headline or footrope by the total length of the fully stretched netting mounted to it. This ratio dictates how open the individual meshes will be, directly influencing the net's shape, filtering efficiency, and catching characteristics.

48. (D) Vertically elongated diamond
Mounting a netting panel with a hanging ratio of 0.5 causes the meshes to stretch vertically, resulting in a vertically elongated diamond shape. This configuration is widely used in gillnets to ensure the mesh opening remains receptive to fish swimming forward, optimizing the chances of gilling or wedging the target species.

49. (A) Entangling
A lower hanging ratio causes the netting to hang loosely, creating a baggy profile with highly flexible meshes. This loose hanging is ideal for capturing fish by entangling them in folds of webbing, rather than relying on the precise sizing required for gilling, making it highly effective for catching diverse species of varying sizes.

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50. (A) I, II, IV and V
Calculating the theoretical area of a rigged netting panel requires knowing the hanging ratio, the stretched netting length, the mesh bar length, and the total number of meshes in depth. The twist direction of the twine does not affect the physical dimensions or the geometric area of the completed panel.

51. (A) To reduce knot slippage in slippery monofilament twines
Synthetic monofilament twines have extremely smooth, slippery surfaces that cause standard knots to loosen and slip under tension. Utilizing a double sheet bend adds an extra turn of the twine within the knot, significantly increasing friction and locking the knot securely in place to maintain consistent mesh sizes throughout the net.

52. (D) It creates less hydrodynamic resistance and abrasion.
Knotless netting eliminates the raised, bulky knots found in traditional nets, resulting in a much smoother surface profile. This design significantly reduces hydrodynamic drag, lowering fuel consumption during towing, while minimizing mechanical abrasion on fish skin, which is crucial for preserving the quality of catch and aquaculture stock.

53. (B) Catamaran
The catamaran is a traditional Indian fishing craft constructed by lashing together several shaped logs of light wood to form a stable floating raft. This highly buoyant and flexible

spreading force needed to open the net mouth while keeping hydrodynamic drag and vessel fuel consumption to a minimum.

98. (C) Warp-depth ratio (or Scope)
The warp-depth ratio, also known as scope, is the ratio of the length of towing wire let out to the actual depth of the water. Maintaining the correct scope is critical in bottom trawling to ensure the otter boards and net maintain stable contact with the seabed at varying speeds.

99. (A) Trammel net
A trammel net is a passive entangling gear composed of three parallel layers of netting mounted on the same ropes. It features two outer layers of large mesh and a loose inner layer of fine mesh, which forms a secure pocket when fish push the fine webbing through the larger openings.

100. (A) I and II
Gillnets are highly size-selective passive gears that capture fish when they attempt to swim through the webbing and become wedged, gilled, or entangled in a single mesh. They do not require high-speed towing, but remain stationary in the water column, relying entirely on the natural movement of fish.

101. (D) Tapered funnel to guide animals in and prevent escape
The entrance of a fish pot or lobster trap is designed as a tapered, inward-pointing funnel. This shape easily guides scavengers toward the bait inside, but makes it extremely difficult for them to locate the narrow opening from the inside, trapping them securely until the gear is hauled.

102. (B) By anchors or weights attached to the ends of the mainline
Bottom set longlines are secured to the seabed using heavy anchors or metal weights attached at both ends of the mainline. This rigging keeps the line stationary and close to the substrate, preventing currents from dragging the gear, which is critical for targeting demersal species.

103. (C) Transparent polyamide monofilament
Modern commercial gillnets are constructed primarily from transparent polyamide monofilament. This single, clear strand is nearly invisible in water, preventing fish from detecting the net barrier, which drastically improves catching efficiency compared to traditional twisted cotton or highly visible colored synthetic twines.

104. (C) Handlining
Handlining is a passive, highly selective fishing method with minimal environmental impact. Because it does not contact or scrape the seabed, it preserves fragile benthic habitats, while allowing fish to be brought on board individually, which ensures exceptional catch quality and minimizes unwanted by-catch.

105. (B) Reducing hull fouling and optimizing engine RPM (steaming at economical speeds)
Green fishing initiatives focus on reducing greenhouse gas emissions by optimizing vessel efficiency. Periodically cleaning the hull to remove biofouling reduces drag, while operating the engine at its most economical RPM significantly lowers fuel consumption per voyage without compromising safety or overall catching capacity.

106. (B) They operate just off the seabed, reducing bottom impact and drag.
Semi-pelagic trawl doors are designed to fly just above the seabed rather than dragging directly on it. This modern rigging significantly reduces physical damage to fragile benthic ecosystems, while lowering friction and hydrodynamic drag, which translates into substantial fuel savings for the fishing vessel.

107. (C) Unintentional capture of non-target species
By-catch is the accidental capture of non-target species, including undersized commercial fish, marine mammals, seabirds, or turtles, during a fishing operation. Minimizing by-catch is a major focus of modern sustainable fisheries management, which uses selective gear modifications and excluder devices to protect marine biodiversity.

108. (B) The physical size and shape differences between target and non-target species
Rigid grid By-catch Reduction Devices, such as the Nordmøre grid, sort catch mechanically based on physical size and shape. Smaller target species like shrimp pass easily through the narrow bar spacings into the codend, while larger non-target finfish or debris are deflected upward toward an escape opening.

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109. (D) Square mesh window (panel)
A square mesh window is a soft-panel selective device integrated into the top section of a trawl codend. Because square meshes remain open under tension, they allow juvenile or small finfish, which actively swim upward when fatigued, to escape easily before being compressed in the codend.

110. (A) I, II and IV
Square mesh codends maintain their open shape under tension and do not distort as catch accumulates, allowing juvenile round fish to escape easily. This design significantly reduces hydrodynamic drag compared to diamond meshes, which tend to close under load and block escape pathways.

111. (A) An angled rigid grid of deflector bars leading to an escape opening
A Turtle Excluder Device consists of a rigid metal grid of deflector bars installed at an angle inside the trawl extension. Shrimp pass easily through the bars into the codend, while large sea turtles strike the bars and are directed upward or downward through a flexible escape opening.

112. (B) 40° to 55°
The optimal angle of installation for a Turtle Excluder Device grid is forty to fifty-five degrees. This specific slope ensures that large objects and turtles slide smoothly along the bars toward the escape opening, while maintaining high retention rates of target shrimp passing through the grid.

113. (D) On the top or side panels of the codend to allow finfish to swim out
A Fisheye is a rigid, cone-shaped frame that creates a permanent, forward-facing opening in the top or side panels of a trawl codend. It utilizes the strong swimming ability of finfish, allowing them to turn around and escape through the opening, while passive shrimp pass into the codend.

114. (B) They are passively swept backward into the codend.
Selective devices exploit the behavioral differences between species. When entering a trawl net, shrimp do not possess the strong, sustained swimming capacity of finfish and are passively swept straight back into the codend, whereas fish actively swim forward or upward, allowing them to escape through specialized openings.

115. (B) Associate with floating objects in the open ocean
Fish Aggregating Devices exploit the natural behavior of many pelagic fish species, such as tuna, mahi-mahi, and wahoo, to aggregate beneath floating structures in the open sea. This grouping behavior allows fishers to locate and capture schools more efficiently, reducing search times and fuel costs.

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116. (A) A combination of sinking and floating ropes forming a catenary curve
To prevent mooring line failure from extreme tension or seabed abrasion, moored FADs often combine sinking and floating ropes. This design creates a catenary curve in the water column that absorbs the energy of ocean swells and currents, preventing the line from rubbing against the seabed or snapping.

117. (C) Southeast Asia (Philippines, Indonesia)
The Payao is a highly successful traditional Fish Aggregating Device widely utilized in Southeast Asian countries like the Philippines and Indonesia. Originally made from bamboo rafts with hanging palm fronds, modern versions are key to local artisanal and commercial purse seine operations targeting pelagic tuna.

118. (B) GPS buoys often integrated with echo sounders
Industrial tuna purse seiners equip drifting FADs with smart GPS tracking buoys that feature integrated echo sounders. These high-tech buoys transmit real-time satellite data showing the exact location of the FAD and the estimated biomass of fish aggregated beneath it, optimizing vessel routing.

119. (B) The time taken for an acoustic pulse to travel to the target and return
Echo sounders calculate water depth and detect fish by measuring the precise time elapsed between transmitting an acoustic pulse from the transducer and receiving its returning echo. Multiplying this travel time by the speed of sound in water determines the exact distance to the target.

120. (A) I, II and IV
Low-frequency acoustic signals penetrate deeper into the water column because they suffer less

attenuation. Conversely, high-frequency signals, which have shorter wavelengths, provide much higher target resolution in shallow waters but are attenuated rapidly, limiting their depth penetration compared to low-frequency waves.

121. (B) Sound Navigation And Ranging
SONAR stands for Sound Navigation and Ranging. It is an acoustic technology used to navigate, communicate, and detect objects on or under the surface of the water, utilizing sound propagation to map the seabed and locate pelagic fish schools around a vessel.

122. (D) Horizontally around the vessel over 360 degrees
Unlike standard vertical echo sounders, omnidirectional fisheries SONAR systems project their acoustic beams horizontally in a three hundred and sixty-degree pattern around the vessel. This wide scanning area allows skippers to search for, track, and intercept moving schools of pelagic fish at significant horizontal distances.

123. (A) The presence and size of its gas-filled swim bladder
The acoustic target strength of a fish is primarily determined by its gas-filled swim bladder, which creates a significant density contrast with the surrounding water. This organ reflects up to ninety percent of the acoustic energy, making it the most important anatomical feature for sonar detection and biomass estimation.

124. (B) Squids and small pelagics like sardines
Light fishing exploits the natural positive phototactic behavior of specific marine species, notably squids and small schooling pelagics like sardines and anchovies. Attracting these organisms to the surface using powerful metal halide or LED lamps allows fishers to aggregate and harvest them efficiently with purse seines or jigging gear.

125. (B) Sea Surface Temperature (SST) and Chlorophyll-a concentration
Potential Fishing Zone advisories in India are generated by analyzing satellite data of Sea Surface Temperature and Chlorophyll-a concentration. Overlapping temperature gradients, or fronts, with high chlorophyll concentrations indicates areas of high primary productivity where pelagic fish schools are highly likely to aggregate.

126. (A) Trilateration of signals from at least four satellites
The Global Positioning System calculates a vessel's exact position by performing mathematical trilateration using signals received from at least four satellites. By measuring the precise time delay of each signal, the receiver determines its latitude, longitude, altitude, and time offset relative to the atomic clocks in space.

127. (D) To allow regulatory authorities to track vessel location, speed, and course for compliance
Vessel Monitoring Systems are secure transmitters installed on commercial fishing vessels that automatically report the vessel's identification, GPS position, speed, and heading to fisheries management authorities. This tracking is crucial for monitoring compliance with marine protected areas and enforcing seasonal closures.

128. (B) VHF Radiotelephone
The Very High Frequency radiotelephone is the standard communication tool for short-range voice transmission in coastal fisheries, typically operating on a line-of-sight basis. It is used for ship-to-ship coordination, communicating with harbor authorities, and monitoring emergency distress channels like Channel sixteen.

129. (A) Real-time fuel tank level
The Automatic Identification System transmits static and dynamic vessel data, including the boat name, Maritime Mobile Service Identity number, coordinates, speed over ground, and navigational status. It does not transmit internal engineering or fuel tank levels, focusing instead on collision avoidance and tracking.

130. (A) Satellite captures data → INCOIS processes data into maps → Information disseminated via SMS/boards to harbors → Fisherman navigates to coordinates
Generating and utilizing Potential Fishing Zone advisories begins with satellites capturing oceanographic data. INCOIS processes these raw data into localized maps, which are then disseminated to harbors and fishers via SMS or electronic display boards, allowing fishers to navigate directly to highly productive coordinates.

131. (A) Strong tidal flows to push fish into the net
Stake nets are highly effective passive gears that must be deployed in estuaries or coastal channels

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experiencing strong tidal flows. The fast-moving current physically forces fish, shrimp, and crabs into the open mouth of the stationary net, which is anchored firmly to the substrate by wooden stakes.

132. (A) Higher resistance to rotting and degradation
Synthetic materials such as polyethylene, polyamide, and polyester offer outstanding resistance to microbial rotting, chemical degradation, and abrasion. This longevity makes them far superior to traditional natural fibers, which degrade rapidly when wet, although their durability poses a persistent environmental threat if lost at sea.

133. (B) Maximum towing force
Bollard pull is a measure of the maximum horizontal pulling force a vessel can exert at zero speed when tied securely to a stationary shore bollard. This parameter is critical for evaluating the towing performance and capability of trawlers, which require high thrust to pull heavy nets.

134. (B) Polypropylene (PP)
Polypropylene is highly susceptible to photochemical degradation when exposed to the ultraviolet radiation in sunlight. Without the addition of specialized UV stabilizers, carbon black, or protective dyes, prolonged exposure causes the fibers to become brittle, lose tensile strength, and disintegrate rapidly in outdoor marine environments.

135. (C) Storing catch in deep, unpartitioned bulk holds minimizes crushing.
Storing fish in deep, unpartitioned bulk holds is a poor practice because the cumulative weight of the catch on top crushes the fish at the bottom, causing severe physical bruising, loss of flesh texture, and rapid spoilage. Utilizing shelved or boxed storage systems minimizes physical damage.

136. (A) To absorb and reflect wave energy, providing a calm basin for vessels
A breakwater is a massive, engineered coastal barrier constructed to absorb, dissipate, and reflect incoming wave energy. By blocking heavy swells, it creates a sheltered, calm water basin inside the fishing harbor, allowing vessels to safely navigate, berth, load cargo, and undergo maintenance.

137. (C) A solid, stationary structure parallel to the shoreline for loading and unloading
A quay is a solid, permanent structure constructed parallel to the shoreline inside a harbor basin. It provides a stable berthing area for fishing vessels, allowing them to tie up alongside for the efficient unloading of catch, loading of ice and fuel, and safe movement of crew and vehicles.

138. (A) Ice plants and cold storages
Maintaining the cold chain is critical to prevent post-harvest spoilage of fish, requiring dedicated ice plants and insulated cold storage facilities at landing centers. Having a steady supply of ice ensures that the catch is chilled immediately upon landing and remains at low temperatures during transport to markets.

139. (B) The transport of sand and sediment along the coast by wave action
Littoral drift is the continuous movement of sand and sediment parallel to the shoreline, driven by oblique incoming waves and coastal currents. Evaluating this sediment transport is critical when choosing a harbor site, as poorly designed breakwaters can trap sediment, causing rapid siltation of the entrance channel.

140. (A) I → III → IV → II → V
A typical commercial fishing trip starts with steaming to the selected grounds. The crew then sets or shoots the gear, hauls it back once the soak time is complete, and immediately sorts and chills the catch on deck before returning to harbor to unload and sell the fish.

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141. (B) Sea water, crushed ice, and the fish catch
Utilizing chilled sea water involves mixing clean seawater, crushed ice, and the fresh fish catch within insulated holds on the vessel. This technique cools the fish very rapidly due to the high heat transfer of the liquid medium, preventing physical bruising and maintaining high quality throughout the voyage.

142. (B) Launching and hauling out vessels for repair and maintenance
A slipway is a sloped concrete ramp extending from the land into the harbor water, equipped with rails or cradles. It is designed to safely launch new vessels or haul existing boats out of the water, allowing shipwrights to inspect, clean, paint, and repair the underwater hull and propulsion gear.

143. (B) Ghost fishing
Ghost fishing occurs when lost, discarded, or abandoned synthetic fishing nets and traps continue to capture and kill marine organisms indefinitely. Because modern synthetics do not degrade, these lost gears act as self-perpetuating traps, depleting commercial fish stocks and killing protected marine mammals and turtles.

144. (B) Biodegradable escape panels or rot cords in traps
To prevent lost traps from ghost fishing, modern regulations mandate integrating biodegradable escape panels secured with organic cotton rot cords. If a trap is lost, these cords dissolve in seawater after a few weeks, opening a large panel that allows trapped crabs or lobsters to escape safely.

145. (B) Marine mammals (e.g., dolphins and porpoises)
Acoustic pingers are small, battery-powered devices attached to the headline of gillnets. They emit regular, low-intensity acoustic signals that alert echolocating marine mammals, such as dolphins and harbor porpoises, to the presence of the invisible net barrier, successfully preventing them from swimming into the net and drowning.

146. (B) A crown of unbarbed hooks (prongs) surrounding a lure
A squid jig is a specialized fishing lure distinguished by having one or more circular crowns of sharp, unbarbed wire prongs surrounding a brightly colored, fluorescent body. When squids strike the lure, their tentacles are snagged by the upward-pointing prongs, which allow easy, automated release during hauling.

147. (C) Azimuth thruster (Z-drive)
Azimuth thrusters can rotate three hundred and sixty degrees horizontally, allowing them to direct thrust in any direction. This capability provides exceptional maneuverability, allowing vessels to turn in their own length and maintain position in tight harbors, eliminating the need for a conventional rudder and steering system.

148. (A) Increase bollard pull and towing efficiency at low speeds
Enclosing a propeller in a Kort nozzle channels the flow of water, which significantly increases thrust and bollard pull at low towing speeds. This hydrodynamic shroud is highly beneficial for trawlers, allowing them to tow heavier nets or operate larger propellers with less engine horsepower.

149. (B) Scuppers or freeing ports
Scuppers and freeing ports are designed openings along the bulwarks of a vessel's main deck. They allow water washing over the deck from heavy seas or rain to drain rapidly overboard, preventing water accumulation that would otherwise create a dangerous free surface effect and compromise vessel stability.

150. (A) Both A and R are true and R is the correct explanation of A.
Direct physical contact between dissimilar metals, such as an aluminum hull and a bronze propeller in a conductive seawater electrolyte, forms a highly active galvanic cell. The less noble aluminum acts as an anode and corrodes rapidly, requiring complete electrical isolation and sacrificial zinc anodes to protect the hull.

151. (A) Hydrodynamic lift
Kites or depressors used in pelagic trawling function on the principle of hydrodynamic lift. As the net is towed forward, the flow of water over the curved surface of these devices generates an upward or downward force, which actively spreads the net mouth vertically without adding dead weight.

152. (B) Bating
Bating is a traditional net-making term that refers to the systematic reduction of the number of meshes in successive rows of a panel. This tapering technique is essential for shaping the net body, allowing the designer to reduce the circumference of the net from the mouth toward the codend.

153. (B) Increasing the number of meshes in a row to widen the panel
Creasing is a net-shaping technique where extra meshes are intentionally added to a row of netting. This process increases the width and overall circumference of the netting panel as it progresses, allowing designers to create specialized shapes and volumetric expansion in specific sections of the net.

154. (A) It forms a straight diagonal edge.
Cutting a netting panel along all bars, known as an AB cut, involves slicing diagonally through the mesh, cutting one bar of every mesh sequentially.

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221. (A) The reinforced, thicker meshes at the edges of a netting panel meant to take extra strain
The selvage of a fishing net consists of several rows of reinforced, thicker meshes running along the borders of a netting panel. These reinforced edges are designed to absorb extra mechanical tension and wear when the panel is joined to other panels or mounted to supporting ropes.

222. (A) Hanging
Hanging is the precise technical process of attaching a netting panel to a supporting rope, such as a headline or footrope. The hanging ratio chosen dictates the openness of the meshes, which directly determines the filtering efficiency, hydrodynamic drag, and catching performance of the completed fishing gear.

223. (A) A sheet bend is superior for joining two ropes of unequal diameter.
A sheet bend is highly superior to a reef knot when joining two ropes of unequal diameter, as it maintains its grip and resists slipping under tension. A reef knot, when used to join mismatched lines, can easily capsize and fail, posing a significant hazard during heavy deck operations.

224. (A) A properly made splice retains a much higher percentage of the rope's original breaking strength than a knot.
Splicing is preferred over knotting because a properly made splice retains up to ninety percent of the rope's original breaking strength, whereas a knot introduces sharp bends that concentrate stress, reducing strength by forty to fifty percent. Splicing ensures the rope remains strong and reliable under heavy loads.

225. (A) Form a permanent loop at the end of a rope
An eye splice is a traditional rigging technique used to form a permanent, high-strength loop at the end of a rope by tucking the unlaid strands back into the standing part. This loop is ideal for attaching blocks, shackles, or anchoring lines, maintaining maximum breaking strength.

226. (A) Forcing oakum or cotton into the seams between hull planks to make them watertight
Caulking is a traditional wooden boat building technique where loose fibers of oakum or cotton are driven tightly into the narrow seams between the hull planks. This material is then sealed with pitch or marine sealant, which expands when wet to ensure the hull remains completely watertight.

227. (C) 2003 (with full phase-out by 2008)
The International Maritime Organization adopted the Anti-fouling Systems Convention in 2001, which established a global ban on the application of toxic organotin compounds like tributyltin starting in 2003. This ban was followed by a complete phase-out by 2008, prohibiting any vessel from carrying active TBT on its hull.

228. (A) Ceases to function because the seawater electrolyte is missing
Cathodic protection relies on a complete electrochemical circuit to transfer electrons from the sacrificial anode to the steel hull. When a vessel is dry-docked, the missing seawater electrolyte breaks this circuit, causing the system to cease functioning until the vessel is submerged and the electrolyte is restored.

229. (A) Shipworms
Teredo navalis, commonly known as the shipworm, is a highly destructive marine bivalve mollusc with a worm-like body. It bores deep tunnels into submerged wooden structures and wooden boat hulls, feeding on cellulose and rapidly honeycomb-boring the timber, which severely compromises the structural integrity of the craft.

230. (A) P-2, Q-4, R-1, S-3
Transducers convert electrical signals to sound. A net-sonde monitors trawl geometry. Omnidirectional sonar scans a three hundred and sixty-degree area horizontally to locate pelagic schools. Acoustic Doppler Current Profilers measure water velocity over a range of depths by analyzing the precise frequency shift of returning sound waves.

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231. (A) A narrower, more focused beam angle
For a transducer of a fixed physical size, increasing the acoustic frequency results in a much narrower and more focused beam angle. This narrow beam concentrates acoustic energy, providing high-resolution targets and excellent detail of the seabed and fish directly beneath the vessel, but reducing the overall scanning area.

232. (A) Echo integration
Echo integration is a scientific acoustic technique used to estimate the total biomass of fish schools.

the net mouth wide open, this method completely eliminates the need for heavy, fuel-consuming otter boards, reducing overall hydrodynamic drag and lowering the required horsepower per vessel.

166. (A) It eliminates engine noise over the net, reducing fish startle responses.
In pair trawling, the two vessels steam parallel to each other, well ahead and to the sides of the oncoming net. This path ensures that engine noise and wake do not pass directly over the net, preventing fish from being startled and escaping before the net mouth reaches them.

167. (A) Benthic shrimp
Outrigger trawling is a highly specialized fishing method that utilizes two long booms, or outriggers, extending from the sides of the vessel to tow multiple nets simultaneously. This method is predominantly used in commercial fisheries targeting benthic shrimp, as it maximizes the swept area across flat, muddy seabeds.

168. (A) Sampling the bottom to estimate shrimp abundance
A try net is a small, easily handled sample net towed alongside the main trawls in outrigger shrimp fisheries. The crew hauls this small net periodically to quickly sample the seabed, estimating shrimp abundance and species composition to decide whether to continue fishing in the area.

169. (A) Disturbing sediment to force organisms into the net
A tickler chain is a heavy metal chain rigged ahead of the footrope of a bottom trawl. As it drags along the seabed, it disturbs the sediment and startles bottom-dwelling species like shrimp and flatfish, forcing them to jump upward where they are easily swept into the advancing net.

170. (A) I and II
Ultra-high-molecular-weight polyethylene warps offer an exceptional strength-to-weight ratio, surpassing traditional steel wire ropes while remaining lightweight. Because they have a specific gravity less than water, they float, which prevents them from dragging on the seabed, and they are completely immune to rust and corrosion.

171. (B) Allow juvenile and undersized fish to escape and reach reproductive maturity
Regulating the minimum mesh size is a fundamental input control in fisheries management. It ensures that the mesh openings remain large enough to allow juvenile and undersized fish to escape unharmed, protecting the reproductive stock and helping to maintain the long-term sustainability of the targeted population.

172. (B) The state under whose flag the vessel is registered
The flag state is the country where a vessel is registered, which grants it the right to fly that state's flag. Under international maritime law, the flag state holds primary responsibility for enforcing safety regulations, crewing standards, and environmental compliance on board its registered vessels, regardless of their location.

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173. (A) 2
Marine safety regulations require small mechanized fishing vessels under twenty-four meters in length to carry a minimum of two approved lifebuoys on board. These lifebuoys must be stowed in easily accessible positions on both sides of the vessel, ready for immediate deployment in a man-overboard emergency.

174. (B) Solid stream of water
Using a solid stream of water on a live electrical fire is extremely dangerous because water is highly conductive. This action can cause severe electrical shock or electrocution to the person operating the hose, while spreading the current and causing short circuits that can damage other onboard systems.

175. (A) Pumping out water and oil from the lower inner hull
The bilge system is designed to collect and pump out water, oil, and condensation that accumulate in the lowest inner compartments of the vessel's hull. Keeping the bilge clear is critical to maintain stability, prevent internal corrosion, and avoid the accumulation of flammable fluids in the machinery spaces.

176. (A) Partially filled tanks or fish holds where liquids can slosh from side to side
The free surface effect occurs when liquids in partially filled tanks or holds slosh transversely as the vessel rolls. This movement shifts the center

of gravity toward the direction of the heel, which reduces the righting lever and can dangerously compromise the vessel's static stability, risking capsizing.

177. (A) The added weight of ice on the superstructure drastically raises the center of gravity
Icing occurs when freezing spray accumulates on the superstructure and rigging of a vessel operating in high-latitude winter fisheries. The substantial weight of this ice raises the vessel's center of gravity, which drastically reduces its metacentric height and righting energy, creating a high risk of capsizing.

178. (A) The difference between the forward and aft drafts
Trim is defined as the difference between the drafts measured at the bow and the stern of a vessel. It indicates the longitudinal inclination of the hull in the water, which directly affects the vessel's steering, speed, propeller immersion, and overall fuel efficiency during transit and fishing operations.

179. (A) The draft aft is greater than the draft forward
A vessel is said to be trimming by the stern when its draft at the stern is greater than its draft at the bow. This configuration is common in commercial fishing vessels, as it ensures deep propeller immersion, improves steering response, and maintains stable towing power during trawling operations.

180. (C) I, II and III
The hydrodynamic performance of an otter board depends on its angle of attack, height-to-length aspect ratio, and weight in water, which together determine its spreading force and seabed contact. The cosmetic color of the board does not affect its hydrodynamic characteristics or physical efficiency during fishing.

181. (A) Higher lift-to-drag ratio, making it more efficient
A high aspect ratio otter board is taller than it is long, which provides a higher lift-to-drag ratio compared to a low aspect ratio board. This design generates a strong horizontal spreading force with less hydrodynamic drag, making it highly fuel-efficient and ideal for mid-water or pelagic trawling.

182. (A) Are highly stable and can easily override bottom obstacles without falling over flat
V-shaped otter boards are highly stable bottom trawling doors. Their angled, V-profile allows them to ride easily over rocks, reefs, and irregular seabed obstructions without falling flat or digging in, making them highly versatile for commercial trawling operations on diverse and challenging fishing grounds.

183. (A) Benthic flatfish like sole and plaice
Beam trawling uses a heavy, rigid steel beam to hold the mouth of the net open horizontally, which allows it to maintain close contact with the seabed. This method is highly effective for capturing benthic flatfish like sole and plaice, which naturally bury themselves in sandy or muddy substrates.

184. (A) Causing severe physical impact and plowing of the benthic ecosystem
Beam trawling with heavy tickler chains or chain matrices is criticized for its significant environmental impact. Dragging these heavy steel chains across the seabed plows the substrate, flattens benthic structures, and destroys complex habitats, which can severely disrupt fragile marine ecosystems and deplete non-target benthic communities.

185. (A) It significantly reduces seabed disturbance and fuel consumption.
Electric pulse trawling replaces heavy steel chains with electrodes that emit brief electrical pulses to startle flatfish, causing them to jump into the net. This system significantly reduces seabed disturbance and lowers the overall weight and drag of the gear, resulting in substantial fuel savings for the vessel.

186. (A) Heavy lead weights on the bottom line (leadline)
To prevent pelagic fish from escaping downward when surrounded by a purse seine, the net must sink as quickly as possible. This rapid sinking is achieved by rigging the bottom line with heavy lead weights, which pull the lower webbing down rapidly before the purse line is winched closed.

187. (A) The reinforced section of netting where the catch is concentrated before brailing
The bunt is the heavily reinforced section of netting located at one end of a purse seine. Once the net is fully pursed and hauled, the

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concentrated catch is gathered in this heavy-gauge webbing, which is designed to withstand the immense weight of the fish during brailing or pumping operations.

188. (A) Transferring the concentrated fish from the bunt of the net onto the vessel using a large scoop net or fish pump
Brailing is the process of transferring the concentrated catch from the bunt of a purse seine onto the vessel. This operation utilizes a large, mechanically operated scoop net, or brailer, or a specialized fish pump, allowing the crew to lift tons of fish on deck quickly and safely.

189. (A) Skiff
A skiff is a powerful, open auxiliary boat carried on the stern of a purse seiner. During setting, the skiff is launched into the water, holding one end of the net stationary while the main vessel circles the fish school, helping to deploy and stabilize the net.

190. (A) I, II, IV and V
Traditional passive gears like pots and traps offer low fuel consumption, yield high-quality live catch, and are highly selective. Unlike heavy bottom trawls, these stationary gears do not drag along the seabed, making them environmentally friendly with minimal physical impact on the benthic ecosystem.

191. (A) Submerging a horizontal net, congregating fish above it (often with light/bait), and rapidly lifting it out of the water
Lift nets operate by submerging a flat or bag-shaped panel of netting horizontally in the water. Once target fish are attracted over the webbing, often using lights or bait, the net is rapidly raised out of the water, trapping the catch inside the bag before they can escape.

192. (A) Shore-operated lift net
The Chinese dip net, a common sight along the coast of Kochi, India, is a prime example of a shore-operated lift net. It uses a massive, counterweighted wooden cantilever structure to lower a large horizontal net into the water, which is then raised by hand to harvest fish.

193. (A) A net shot in a semi-circle from the shore and hauled entirely onto the beach by hand or winches
Beach seines are traditional gears deployed in a semi-circle from the shoreline using a small boat. Once the net is set, crews on the beach pull both ends of the hauling ropes simultaneously, drawing the net and the captured fish onto the sand by hand or using mechanical winches.

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194. (A) It causes less deep hooking (gut hooking) in turtles and fish, improving post-release survival.
Circle hooks are designed with an inward-pointing tip, which prevents them from catching in the deep throat or gut of an animal. Instead, they slide to the corner of the mouth to hook securely, which significantly reduces internal injuries and improves the survival of released by-catch, such as sea turtles.

195. (A) Squid and saury
Pelagic longline fisheries targeting tuna and billfish rely on high-quality natural bait to attract fish over long distances. Fresh or frozen squid and small pelagic fish like saury are highly effective baits, providing strong olfactory and visual cues that attract target species to the hooks.

196. (A) A swivel
A swivel is a critical component integrated into each snood to prevent the line from twisting or kinking. When a hooked fish spins or fights, the swivel rotates freely, preventing the branch line from tangling around the mainline, which ensures the gear remains intact and easy to haul.

197. (A) Towing multiple baited hooks or lures near the surface behind a moving vessel
Trolling involves towing several independent fishing lines equipped with baited hooks or artificial lures through the water behind a vessel. The lines are suspended from long outrigger poles, or outriggers, to prevent tangling, targeting fast-swimming pelagic species like tuna, mackerel, and kingfish.

198. (A) Skipjack and small yellowfin tuna
Pole-and-line fishing is a highly selective, low-impact method used to target pelagic skipjack and small yellowfin tuna. Because fish are caught individually using barbless hooks, this method eliminates the risk of by-catch of marine mammals and sea turtles, making it highly valued in sustainable seafood markets.

199. (A) Throwing live baitfish into the water to whip the target school into a feeding frenzy
Chumming is a vital technique in pole-and-line fishing where live baitfish are thrown into the

water while spraying water on the surface. This action mimics a schooling prey group, whipping the tuna into a feeding frenzy where they bite the unbaited hooks rapidly.

200. (A) Both A and R are true and R is the correct explanation of A.
Integrating square mesh panels into the top of a codend is highly effective for reducing by-catch. Unlike traditional diamond meshes that close up under the heavy tension of towing, square meshes remain fully open, allowing juvenile finfish to escape easily before they are compressed, trapped, and damaged in the codend.

201. (A) Sustainable or responsible fishing
Sustainable or responsible fishing refers to harvesting methods that align with the guidelines of the FAO Code of Conduct for Responsible Fisheries. These practices focus on conserving aquatic ecosystems, minimizing by-catch, preventing overfishing, and ensuring that marine resources remain abundant and viable for future generations of fishers.

202. (A) Illegal, Unreported, and Unregulated
IUU stands for Illegal, Unreported, and Unregulated fishing, which represents a major threat to global marine ecosystems and sustainable fisheries management. This activity undermines conservation efforts, distorts local and international seafood markets, and depletes critical fish stocks, requiring international cooperation and strict port controls to combat.

203. (A) Shrimp from by-catch of cod and haddock
The Nordmøre grid was developed in Norway to separate target northern shrimp from the unwanted by-catch of juvenile cod and haddock. This rigid sorting grid allows the small shrimp to pass easily between the bars into the codend, while directing larger finfish out of the net through an escape opening.

204. (A) Prevent the entanglement of dolphins and facilitate their escape
The Medina panel is a strip of fine-mesh netting installed in the back section of tuna purse seines to prevent dolphin entanglement. During the backdown maneuver, this fine mesh keeps dolphins from snagging their snouts or fins, allowing them to swim safely over the corkline and escape the net.

205. (A) Harbor porpoises
Acoustic pingers attached to gillnets have proven highly successful in reducing the incidental by-catch of harbor porpoises. The regular acoustic signals alert these echolocating cetaceans to the presence of the net, allowing them to navigate away from the barrier and preventing them from becoming entangled and drowning in the mesh.

206. (A) Pelagic seabirds (like albatrosses) and sea turtles
Modifying longline hook designs, such as replacing J-hooks with circle hooks, and using fish bait instead of squid, significantly reduces the accidental capture of pelagic seabirds like albatrosses and sea turtles. These measures prevent the deep ingestion of hooks and reduce the overall attraction of non-target species to the lines.

207. (A) Frighten seabirds away from diving onto baited hooks before they sink
A Tori line, or bird-scaring line, is towed behind a longlining vessel during the setting process. It features bright, hanging streamers that flutter in the wind over the water, scaring foraging seabirds like albatrosses away from diving onto and swallowing the baited hooks before they sink to safe depths.

208. (A) They significantly increase the by-catch of juvenile tuna and non-target species like sharks.
A major ecological concern regarding drifting Fish Aggregating Devices is their tendency to attract diverse marine life, resulting in high rates of by-catch. Concentrating non-target species, such as sharks, sea turtles, and juvenile tuna, leads to high mortality rates when these groups are enclosed within purse seines.

209. (A) Biodegradable materials like bamboo, palm leaves, and cotton ropes
To combat marine plastic pollution and reduce ghost fishing, researchers advocate constructing drifting Fish Aggregating Devices from biodegradable materials. Utilizing organic components like bamboo, palm fronds, and natural cotton ropes ensures that if the FAD is lost, it decomposes harmlessly in seawater without contributing to persistent microplastics.

210. (A) P-4, Q-3, R-1, S-2
Otter boards are essential for opening otter trawls. Purse lines close the bottom of purse

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seines. Snoods carry hooks in longline systems. Tickler chains are heavy metal chains rigged ahead of the footrope on beam trawls to stir up flatfish from the muddy seabed, forcing them into the path of the net.

211. (A) High size and species selectivity with low carbon emission per kg of catch
An eco-friendly fishing gear is defined by its high selectivity, capturing only target species and sizes while allowing non-target organisms to escape unharmed. Additionally, it must have a low physical impact on benthic habitats and require minimal fuel, reducing the overall carbon footprint per kilogram of harvested catch.

212. (A) Small turtles fail to be excluded and pass into the codend.
Spacing the deflector bars of a Turtle Excluder Device too widely allows small sea turtles to pass through the grid and into the codend, failing to exclude them from the catch. To ensure high exclusion rates, bar spacing must comply with strict regulations, typically limited to ten centimeters.

213. (A) Let small, undersized lobsters walk out while retaining legal-sized ones
An escape gap is a small, rigid opening integrated into the side panel of a lobster pot. It is sized precisely to allow juvenile and undersized lobsters to crawl out of the trap while retaining legal-sized specimens, serving as an effective conservation tool that reduces sorting labor on deck.

214. (A) Mass in grams of 9,000 meters of yarn
Denier is a direct yarn numbering system widely used for synthetic fibers like nylon. It is defined as the weight in grams of exactly nine thousand meters of yarn. In this system, a higher denier number indicates a heavier and thicker yarn, which translates to stronger and bulkier twine.

215. (B) Nm 50
The metric count is an indirect yarn numbering system defined as the length of yarn in meters per gram of mass. If fifty thousand meters of a single yarn weigh exactly one kilogram, dividing fifty thousand meters by one thousand grams yields a metric count of fifty, indicating its relative fineness.

216. (C) It floats on the surface.
Polypropylene has a specific gravity of approximately 0.91, which is lower than the density of both fresh and saltwater. Consequently, this synthetic polymer floats naturally on the water surface, making it ideal for ropes, floats, and netting components that must maintain buoyancy without requiring additional floats.

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217. (A) It has very poor resistance to abrasive wear and flex fatigue, and is highly expensive.
Despite its immense tensile strength, Kevlar is rarely used for commercial trawl netting because it has very poor resistance to abrasion and flex fatigue, causing it to degrade quickly when dragged or repeatedly flexed. Additionally, its exceptionally high cost makes it economically impractical for manufacturing large-scale fishing nets.

218. (B) The distance between two adjacent knots (one side of the mesh)
A mesh bar represents a single side of a mesh, defined as the precise distance between two adjacent knots. Measuring the mesh bar length is a fundamental method used in net design and manufacturing to calculate the overall stretched dimensions, surface area, and weight of a netting panel.

219. (A) The knots, which can account for a significant percentage of the total weight
In knotted netting, the individual knots concentrate a significant amount of twine material, accounting for a substantial percentage of the net's total weight. Consequently, calculating the weight of a knotted panel requires accounting for this significant knot factor, unlike knotless netting where twine weight is distributed uniformly along the bars.

220. (A) Both A and R are true and R is the correct explanation of A.
High-density polyethylene is the most common polymer chosen for constructing bottom trawl codends. This material exhibits excellent resistance to abrasion, which is critical for protecting the net from tearing as the codend, filled with catch, is dragged directly across rough, abrasive sand and gravel on the seabed.

243. (A) Reflections of the radar wave from the sea surface (waves) near the vessel
Sea clutter is caused by radar waves reflecting off the tops of nearby ocean waves, creating a dense pattern of random echoes around the center of the display. This noise can mask actual targets, requiring operators to adjust the radar's sensitivity controls to filter out wave returns.

244. (A) A satellite-linked beacon used to transmit a distress alert and location to search and rescue authorities
An Emergency Position Indicating Radio Beacon is a buoyant, waterproof transmitter that, when activated manually or hydrostatically, broadcasts a distress signal to search and rescue satellites. This signal includes the vessel's unique identification and precise GPS coordinates, initiating a rapid, highly targeted search and rescue operation.

245. (A) Showing a series of dots on an approaching vessel's 9 GHz (X-band) RADAR display
A Search and Rescue Transponder is a portable safety device designed to guide rescue teams to a survival craft. When painted by an approaching vessel's nine gigahertz radar, the transponder broadcasts a signal that appears as a series of twelve distinct dots on the radar screen, showing the exact position.

246. (A) Distress, safety, and calling communication
VHF Channel sixteen is reserved internationally as the primary channel for maritime distress, safety, and calling. All vessels equipped with VHF radios are required to maintain a continuous watch on this frequency to receive emergency broadcasts, coordinate search and rescue, and establish initial contact before switching channels.

247. (A) Digital Selective Calling (DSC)
Under the Global Maritime Distress and Safety System, Digital Selective Calling allows a navigator to instantly broadcast a digital distress alert at the push of a red button. This alert transmits the vessel's identity and GPS coordinates to all nearby ships and coastal stations, automating the emergency process.

248. (A) Large industrial vessels requiring significant draft (e.g., > 5 meters) and extensive shore facilities
A deep-sea fishing harbor is specifically engineered with deep approach channels, heavy-duty berthing quays, and extensive shore infrastructure to support large industrial vessels. These facilities accommodate boats with drafts exceeding five meters, providing dedicated fuel, bunkering, massive ice plants, and cold storage needed for long-range voyages.

249. (A) A core of smaller rocks protected by increasingly larger armor stones or concrete units on the outside
A rubble-mound breakwater is constructed by laying a core of quarry-run gravel and smaller rocks, which is then covered by a protective filter layer. The outer slope is armored with massive stones or interlocking concrete units designed to absorb and dissipate the impact force of heavy ocean waves.

250. (A) Artificial concrete armor units used in breakwater construction to interlock and dissipate wave energy
Tetrapods and Accropodes are highly specialized, interlocking concrete armor units used in the construction of marine breakwaters. Their unique geometric shapes are designed to lock together loosely, which allows water to flow through the gaps, dissipating wave energy and preventing erosion far more effectively than traditional rock armor.

251. (A) Sloping, smooth concrete/epoxy floors with adequate drainage and pressurized wash-down systems
Modern hygienic auction halls must feature smooth, non-porous concrete or epoxy-coated floors that slope toward dedicated drainage channels. This design allows for rapid removal of wastewater, preventing bacterial growth and odor accumulation, while pressurized wash-down systems ensure the entire area can be sanitized easily after each landing.

252. (A) The phase of the moon to predict tidal height (high tide vs. low tide)
A vessel skipper must closely monitor the phase of the moon to predict tidal heights when navigating shallow harbor channels. The gravitational pull of the moon dictates the high and low tides, which determines whether a vessel

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It measures the cumulative backscattered acoustic energy from a volume of water, which is directly proportional to the density of the fish, allowing fisheries scientists to calculate the total abundance of fish stocks.

233. (A) Immediately above a sloping or rough seabed
The acoustic blind zone, or dead zone, occurs immediately above the seabed where the trailing edge of the transmitted pulse overlaps with the bottom echo. Within this zone, the echo sounder cannot separate the signal of bottom-dwelling fish from the much stronger seabed return, making demersal fish invisible.

234. (A) A single pulse of acoustic energy transmitted by the transducer
A ping is a single, short pulse of acoustic energy generated by an echo sounder or sonar transducer. This sound wave travels through the water column, reflects off underwater targets such as fish or the seabed, and returns to the receiver to display depth and biomass data on the screen.

235. (C) 1,500 m/s
The velocity of sound in seawater is a critical constant for depth calculation, averaging approximately one thousand five hundred meters per second. This speed is much faster than in air, allowing marine acoustic instruments to quickly receive echoes and display real-time depth and target data to the navigator.

236. (A) Increase in temperature, salinity, and depth (pressure)
The velocity of sound in seawater is directly influenced by temperature, salinity, and hydrostatic pressure. An increase in any of these three physical parameters expands the density and elasticity of the water, which significantly accelerates the speed of the acoustic pulse as it travels through the water column.

237. (A) Thermal infrared sensors
Thermal infrared sensors mounted on satellites are capable of measuring sea surface temperature both day and night. These sensors detect the thermal radiation emitted naturally by the ocean's surface skin, allowing marine scientists to identify thermal fronts, upwelling zones, and current boundaries regardless of solar illumination.

238. (A) High phytoplankton abundance (primary productivity)
Satellites measure ocean color to determine chlorophyll-a concentration, where a high concentration indicates a high abundance of photosynthetic phytoplankton. This primary productivity forms the base of the marine food web, attracting herbivorous zooplankton and schools of pelagic fish, making these areas highly productive potential fishing grounds.

239. (A) A sharp gradient or boundary between two different water masses
A thermal front is a distinct oceanic boundary characterized by a sharp temperature gradient between two different water masses. These zones act as physical barriers that concentrate nutrients, phytoplankton, and forage fish, attracting highly mobile pelagic predators like tuna, which makes fronts key indicators for potential fishing zones.

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240. (A) Because these zones represent areas of high biological productivity and prey concentration
Pelagic species like tuna and mackerel aggregate near thermal fronts and upwelling zones because these areas feature high nutrient enrichment, which stimulates massive blooms of phytoplankton. This concentration of primary food attracts baitfish and squid, creating highly concentrated feeding zones that these predators can exploit highly efficiently.

241. (A) Differential GPS (DGPS)
Differential GPS augments standard GPS by using a network of fixed ground-based reference stations that calculate satellite signal errors. These corrections are transmitted to the vessel's receiver, which cancels out atmospheric delay and clock errors to improve positioning accuracy from fifteen meters down to under a few meters.

242. (A) X-band ($9 GHz$)
X-band marine radars operate at a higher frequency of approximately nine gigahertz, which provides a shorter wavelength and excellent target resolution. This band is highly preferred for detecting small objects, buoys, and shorelines at close range, making it essential for navigation in restricted harbors and low-visibility conditions.

This cutting method results in a clean, straight diagonal edge that is essential for shaping the tapered wings and bellies of modern trawl nets.

155. (A) Transversely (horizontally across the meshes)
A straight transverse cut across the width of a netting panel, cutting two bars of every mesh, is referred to as an N-cut or T-cut. This cut progresses horizontally across the meshes, allowing net makers to cleanly divide or join panels along their width while maintaining consistent mesh geometry.

156. (C) Newtonian drag equation ($R = \frac{1}{2} C_d \rho A v^2$)
The hydrodynamic resistance of a towed trawl net is estimated using the Newtonian drag equation. This formula calculates drag based on water density, the velocity of the net, a drag coefficient, and the projected area of the netting twines, helping engineers design fuel-efficient gears and choose appropriate vessel engines.

157. (A) Microbial degradation (cellulose-digesting bacteria and fungi)
Natural fiber twines like cotton are composed of organic cellulose, which is highly vulnerable to attack by marine bacteria and fungi. If left damp, these microorganisms multiply rapidly and digest the cellulose fibers, causing rapid rotting and a catastrophic loss of tensile strength, unlike synthetic fibers which resist biological decay.

158. (A) Strands interwoven in a tubular or solid pattern
Braided ropes are constructed by interweaving multiple synthetic strands in a tubular or solid pattern, rather than twisting them. This interwoven structure provides exceptional rotational stability and prevents the rope from untwisting or kinking under heavy tension, making it ideal for use as trawl headlines, footropes, and high-performance rigging.

159. (A) They resist untwisting and kinking under heavy tension.
Braided twines provide a balanced, torque-free structure that does not twist or kink when subjected to high tension. This stability makes them far superior to standard twisted twines in constructing large pelagic trawls, as they prevent mesh distortion and ensure the net maintains its designed geometry during complex towing maneuvers.

160. (A) P-2, Q-1, R-4, S-3
RADAR detects surface objects in low visibility. GPS determines precise coordinates. Echo sounders calculate water depth and locate submerged fish. VHF radio is the standard communication tool used for short-range ship-to-ship and ship-to-shore voice transmissions, ensuring effective coordination and safety among nearby fishing vessels.

161. (C) The temperature of the main engine
A net-sonde or trawl eye is an acoustic sensor designed to monitor net geometry and fish behavior, displaying the distance of the headrope to the surface, the footrope to the seabed, and fish entering the net mouth. It does not monitor the vessel's internal propulsion systems or main engine temperatures.

162. (A) Seabed area covered to estimate fish biomass
Swept area refers to the total area of the seabed covered by a trawl net during a specific tow, calculated using the distance towed and the horizontal spread of the net. This parameter is crucial in fisheries science for estimating the absolute density and biomass of demersal fish stocks.

163. (A) Specific species the gear and operation are designed to catch
Target catch refers to the specific species of fish, shrimp, or cephalopods that a particular fishing gear and operation are designed to capture. Gear design, mesh size, fishing depth, and seasonal operations are optimized to maximize the retention of this target catch while minimizing the capture of non-target species.

164. (B) Bottom trawl designed with modified wings and flotation to achieve greater vertical height, targeting semi-pelagic species
A high-opening bottom trawl is designed with modified side panels, longer wings, and extra headline flotation to achieve a significantly greater vertical opening. This design allows the net to capture semi-pelagic species that swim several meters above the seabed, which would escape over a standard low-opening bottom trawl.

165. (C) Otter boards
Pair trawling involves two vessels towing a single trawl net simultaneously. Because the horizontal distance between the two moving vessels keeps

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with a deep draft has sufficient clearance to enter safely.

253. (A) A buoyant platform that rises and falls with the tide, used for safe berthing of small crafts
A floating pontoon is a buoyant deck structure secured to vertical piles, allowing it to rise and fall dynamically with the tide. This design maintains a constant freeboard relative to the water level, providing small crafts with a safe, stable platform for boarding and unloading catch.

254. (A) Lifting or draining a vessel out of the water to inspect and repair the underwater hull and propulsion systems
A dry dock is a specialized basin that can be flooded to allow a vessel to enter, and then sealed and pumped dry. This process exposes the underwater hull, rudder, and propeller, allowing shipwrights to safely inspect, clean, paint anti-fouling, and repair critical structural components.

255. (A) Marine diesel oil and lubricants
Bunkering facilities in a fishing harbor provide vessels with marine diesel fuel and engine lubricants. Having dedicated fuel berths equipped with high-capacity pumps ensures that vessels can refuel quickly and safely, minimizing turnaround times between voyages and maintaining continuous commercial fishing operations.

256. (A) Marine water pollution from oily bilge discharges and accidental spills
Installing oil spill booms and waste reception facilities in a fishing harbor is critical to mitigate marine water pollution. These systems contain and collect oily bilge discharges, lubricants, and garbage from vessels, preventing toxic contaminants from spreading into the wider coastal ecosystem and protecting local fisheries.

257. (A) Provides basic facilities (e.g., small shed, beach landing) mostly for motorized traditional and small mechanized crafts
An artisanal fish landing center differs from a major commercial harbor by focusing on basic, low-cost facilities. It typically features simple beach landing zones, basic sorting sheds, and small auction areas, catering to traditional motorized canoes and small-scale mechanized boats operating within local nearshore waters.

258. (A) Maintain the advertised navigational depth by removing accumulated sediment
Siltation from littoral drift and river deposits gradually reduces the depth of harbor basins and channels. Periodic dredging is required to scoop out this accumulated sediment, maintaining the advertised navigational depth and ensuring that fishing vessels can enter and exit the harbor safely without running aground.

259. (A) A jetty projects out from the shore into the water, whereas a quay is built parallel to the shoreline.
A jetty is a narrow structure that projects outward from the shoreline into the water, serving as a wave barrier or berthing finger. In contrast, a quay is built flush and parallel along the shoreline, providing a continuous, solid wall for heavy cargo handling and vessel berthing.

260. (A) The rate of fish landings and the requirement to maintain the catch below $4^{\circ}C$ during transportation and storage
The capacity of a harbor's ice plant is determined by the total volume and rate of daily fish landings. Sufficient ice must be produced to quickly chill the catch and maintain it below four degrees Celsius, preserving seafood quality during sorting, storage, and subsequent transport to distant consumer markets.

261. (A) Top (square/belly) and Bottom (belly) panels
A standard two-seam bottom trawl is constructed using two primary longitudinal sections of netting, known as the top and bottom panels. These panels are joined along their outer edges to form the main body, wings, and belly of the net, which tapers down toward the codend.

262. (A) Prevent upward escape of fish disturbed by the footrope
The square, or overhang, of a bottom trawl is a section of netting projecting forward on the top panel, hanging over the footrope. As the footrope disturbs demersal fish on the seabed, their natural reaction is to swim upward; the overhang blocks this escape route, guiding them into the net.

263. (A) It is a highly active, high-speed towing gear.
Deep-sea longlining is a passive fishing method, not an active, high-speed towing gear. The mainline, which can extend for tens of

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285. (A) To cool the closed-circuit fresh water of the engine block using outside seawater
A marine heat exchanger functions by circulating hot fresh water from the closed-loop engine cooling system past channels of cool outside seawater. This heat transfer cools the engine block safely without exposing sensitive internal channels to highly corrosive seawater, which would cause rapid scaling, salt deposits, and corrosion.

286. (A) To prevent seawater from entering the hull where the propeller shaft exits
A stuffing box, or stern tube seal, is a mechanical assembly packed with grease-impregnated flax or modern mechanical seals. It is installed where the rotating propeller shaft exits the hull, providing a tight barrier that prevents seawater from leaking into the bilge while allowing the shaft to turn freely.

287. (A) Tensile testing machine (dynamometer)
The breaking strength of synthetic twines is assessed using a tensile testing machine, or dynamometer. This instrument applies a steadily increasing longitudinal force to a sample of twine until it ruptures, recording the maximum load and elongation to evaluate the material's durability and suitability for fishing gear.

288. (A) Elastic (recoverable) stretch and plastic (permanent) elongation
When a synthetic twine is subjected to mechanical loads, its total stretch consists of elastic and plastic components. Elastic stretch is temporary and recovers completely once the load is removed, while plastic elongation represents permanent structural deformation that remains in the fibers, altering the mesh dimensions over time.

289. (B) II, III and IV
Acoustic pingers emit high-frequency ultrasonic clicks, are attached at regular intervals along a gillnet headline, and alert marine mammals to the presence of the net. They do not emit low-frequency predator calls, nor do they harm or kill the animals, serving instead as a safe and effective deterrent.

290. (B) Frictional resistance
Frictional resistance is the primary component of total hull resistance at low speeds, caused by the shear stress of water rubbing against the vessel's wetted surface area. This force is heavily influenced by the hull's surface roughness, wetted area, and speed, requiring clean hulls to maintain fuel efficiency.

291. (A) Water molecules penetrating the gelcoat and reacting with un-cured resin chemicals to form blistering acidic fluid
Osmosis in fiberglass hulls occurs when water molecules slowly penetrate the semi-permeable gelcoat over time. These molecules react with un-cured resin water-soluble components inside the laminate, creating acidic pockets of fluid that exert high osmotic pressure, resulting in the formation of unsightly and structurally weakening blisters.

292. (A) A wide, sufficiently deep area of water within the harbor allowing vessels to safely turn around
A turning basin is a wide, deep water area engineered inside a fishing harbor basin. It provides sufficient maneuvering space for large vessels to safely turn around under their own power or with the help of tugs, allowing them to align with quays or exit channels without colliding with structures.

293. (A) Flake ice or Slurry ice
Flake or slurry ice is highly preferred for packing fragile pelagic fish because it consists of small, smooth, flat pieces that lack sharp edges. This soft texture prevents physical bruising and puncture damage to the fish skin, while providing rapid, uniform cooling due to its large surface area.

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294. (A) Expired flares can be safely disposed of by tossing them in the harbor water.
Expired marine pyrotechnics contain highly toxic, reactive chemicals that pollute the marine environment if discarded in harbor waters. They must be treated as hazardous waste and disposed of through authorized maritime safety agencies or local police departments, ensuring they are not triggered accidentally or left to contaminate waterways.

295. (A) The height and line-of-sight clearance of the antenna
Because marine VHF radio signals travel via line-of-sight propagation, the effective range of communication is dictated by the height of the antenna above sea level. Mounting the antenna on a tall mast maximizes the distance to the

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274. (A) The rapid mechanization of fleets and expansion of aquaculture to boost production
The Blue Revolution in India focused on boosting fish production and modernizing the fisheries sector. It promoted the rapid mechanization of fishing fleets, introduced modern aquaculture techniques, improved landing infrastructure, and enhanced fishers' livelihoods through financial support and technical training across both coastal and inland regions.

275. (A) They are non-biodegradable and contribute persistently to marine microplastics.
A major disadvantage of synthetic netting materials is their high resistance to environmental decay, making them completely non-biodegradable. If lost or discarded at sea, these materials persist for centuries, ghost fishing marine life and slowly breaking down into toxic microplastics that contaminate marine food webs.

276. (A) Clove hitch
A clove hitch is a classic, highly secure knot used to attach a rope temporarily to a spar, post, or net headline. It consists of two opposing half-hitches that grip tightly when under tension, preventing the rope from sliding along the shaft, while remaining very easy to untie.

277. (A) Trawl (connecting the sweep line to the wing ends)
A Dan leno is a heavy wooden or steel hoop or bar used in bottom trawling. It is rigged between the sweep lines and the wing ends of the net, serving to keep the wings vertically open and preventing the net from twisting or snagging as it moves across the seabed.

278. (A) A funnel or valve of netting placed inside the codend to prevent fish from swimming back out
A flapper is a tapered funnel of netting installed inside the intermediate or codend section of a trawl. It acts as a one-way valve, allowing fish to pass easily into the rear of the net, but preventing them from swimming forward and escaping when the towing speed decreases.

279. (A) Protect the actual codend netting from abrasive wear against the seabed
Chafing gear consists of protective layers of heavy netting, canvas, or plastic strips attached to the underside of a trawl's codend. As the codend fills with fish and drags along the bottom, this sacrificial layer absorbs the friction and abrasive wear, protecting the structural netting from tears.

280. (A) A measure of the amount of fishing gear of a specific type used on the fishing grounds over a given unit of time
Fishing effort is a standardized measure of the quantity of fishing gear used over a specific period, such as the number of hours trawled, hooks set, or gillnet sets per day. It is a fundamental parameter in fisheries science used to assess stock exploitation rates and regulate fishing pressure.

281. (A) Relative abundance or biomass of the target fish stock
Catch Per Unit Effort is calculated by dividing the total catch weight by the corresponding fishing effort. Fisheries scientists utilize CPUE as a reliable index of the relative abundance or biomass of a fish stock, assuming that a higher CPUE correlates with a denser and healthier population in the water.

282. (A) The length at which 50% of the fish encountering the gear are retained
The L50 value represents the specific body length at which fifty percent of the fish that encounter the gear are retained, while the other fifty percent escape through the meshes. This parameter is critical for designing selective gears that protect juvenile fish while harvesting mature commercial sizes.

283. (A) Sigmoidal (S-shaped / logistic curve)
The selection curve for a trawl codend typically exhibits a sigmoidal, or S-shaped, logistic profile. This curve shows that extremely small fish have zero retention, intermediate-sized fish are partially retained, and all fish above a certain length threshold are fully retained by the mesh, indicating clear size selectivity.

284. (B) Bell-shaped (unimodal or bimodal)
Unlike trawls, gillnets have a bell-shaped selection curve. Fish are caught only if their girth matches the mesh size, so very small fish swim through, and very large fish cannot penetrate the mesh to be gilled. Only a narrow size range is captured, resulting in a unimodal or bimodal distribution.

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CHAPTER 05
Sustainable Fisheries Management

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2012

1. Which ecological principle dictates that fisheries must not degrade ecosystem structure or function over the long term?
(A) Ecological sustainability
(B) Maximum extraction scaling
(C) Economic rent maximization
(D) Open access continuum

2018

2. Which statement best represents a fundamental component of sustainable fisheries management?
(A) Harvesting rates consistently exceed natural replenishment.
(B) Target species are managed independently of food web dynamics.
(C) Exploitation levels are balanced with ecosystem carrying capacity.
(D) Economic profit is strictly prioritized over stock viability.

2022

3. The precautionary approach in fisheries management is primarily applied when:
(A) Information is uncertain or inadequate.
(B) Scientific data is verified and certain.
(C) Economic returns are consistently low.
(D) Fish stocks are fully underexploited.

2017

4. If a fishery consistently removes apex predators, what ecological effect typically follows within the marine food web?
(A) Immediate increase in predator biomass density.
(B) Stabilization of primary producer communities.
(C) Enhanced genetic diversity of the apex predator.
(D) Trophic cascades within the marine food web.

2007

5. Which parameter serves as a core biological indicator for determining the reproductive viability of a stock?
(A) Gross fleet revenue
(B) Spawning stock biomass
(C) Total number of fishing days
(D) Subsidies provided to fishers

2019

6. All of the following are primary components of sustainable fisheries management EXCEPT:
(A) Protecting critical developmental habitats
(B) Implementing science-based catch limits
(C) Maximizing fishing fleet overcapacity
(D) Minimizing incidental bycatch

2025

7. A manager reduces fishing quotas strictly in response to an unexpected warm climatic anomaly affecting recruitment. This action is a direct application of:
(A) Maximum Economic Yield optimization
(B) Eumetric fishing strategies
(C) Ghost fishing mitigation
(D) Adaptive management principles

2008

8. Which statement regarding ecological principles in fisheries is incorrect?
(A) Fisheries strictly impact only the targeted species in isolation.
(B) Ecosystems possess finite boundaries of carrying capacity.
(C) Harvesting multiple species impacts interspecific competition.
(D) Habitat integrity is vital for successful stock replenishment.

2016

9. What is the most appropriate definition of 'carrying capacity' in the context of fisheries ecology?
(A) The maximum vessel hold capacity allowed per fleet
(B) The maximum biomass an environment can sustainably support
(C) The minimum population size to avoid localized extinction
(D) The total number of licenses that can be issued safely

horizon, bypassing physical obstructions and extending the vessel's communication range.

296. (A) Anchor the mooring lines (hawsers) of a vessel securely to the dock
A bollard is a heavy-duty, short metal post anchored securely to a harbor quay or deck. It is designed to secure a vessel's heavy mooring lines, or hawsers, distributing the tension generated by tides, wind, and currents to keep the vessel safely berthed alongside the dock.

297. (A) Dynamite (blast fishing)
Blast fishing using dynamite is an extremely destructive and illegal harvesting method that causes massive, non-selective mortality of marine life and catastrophic habitat destruction. The shockwave kills all fish, larvae, and invertebrates within its range, while completely shattering fragile coral reef structures that take centuries to recover.

298. (A) Both A and R are true and R is the correct explanation of A.
Deep-sea squid jigging is conducted at night using powerful overhead lighting arrays. Squids exhibit positive phototactic behavior, meaning they are attracted to the illuminated zones to feed on aggregated baitfish. This makes it easy for automated jigging reels to capture them along the shadow boundary beneath the vessel.

299. (A) Overall Length
In vessel design and registration, the abbreviation OAL stands for Overall Length. It measures the maximum length of a vessel's hull from the foremost part of the stem to the aftermost part of the stern, serving as a critical dimension for calculating docking fees, regulatory compliance, and harbor berthing.

300. (B) P-4, Q-2, R-3, S-1
The center of gravity is where total weight acts downward. The center of buoyancy is where upward buoyant forces act. The metacenter is the intersection of vertical lines during a heel, and the metacentric height is the vertical distance between gravity and metacenter, serving as the primary measure of initial static stability.

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kilometers, is set to drift or remain stationary in the water, relying on target pelagic fish to swim to the baited hooks voluntarily, which keeps fuel consumption low.

264. (A) Bar cut - Cutting diagonally across the mesh, breaking one knot at a time
A bar cut is a precise net-making technique where the webbing is sliced diagonally along the mesh bars, cutting one bar of a single mesh at each step. This method is critical for tapering netting panels, allowing designers to create the precise sloping profiles required in modern trawl wings.

265. (A) It possesses extreme resistance to corrosion and biofouling.
Monel metal is a highly valued nickel-copper alloy in marine engineering because of its outstanding resistance to saltwater corrosion and biological fouling. It retains high mechanical strength and durability in harsh marine environments, making it ideal for critical underwater fittings, shafting, and valves despite its high cost.

266. (A) Marine gearbox (reduction gear)
A typical marine propulsion system connects the high-RPM diesel engine to the propeller shaft via a marine reduction gearbox. This critical component reduces the rotational speed of the shaft while increasing torque, allowing the propeller to operate at its most efficient speed to generate optimal thrust for towing.

267. (A) Allow the use of a larger, more efficient propeller to generate high thrust (bollard pull)
The reduction gear allows the marine engine to run at high, power-efficient RPM while turning the propeller shaft at a lower, optimal speed. This configuration enables the vessel to carry a larger, high-pitch propeller that generates the immense thrust and bollard pull needed to tow heavy bottom trawling gear.

268. (A) The formation and violent collapse of low-pressure vapor bubbles on the blade surface, causing pitting
Propeller cavitation occurs when the velocity of the blades creates localized low-pressure regions where water boils into vapor bubbles. As these bubbles move into higher pressure areas, they collapse violently, generating micro-jets of water that strike the blades, causing surface pitting, noise, vibration, and a loss of thrust.

269. (A) The theoretical forward distance the propeller would advance in one complete revolution if moving through a solid medium
Propeller pitch is defined as the theoretical distance the propeller would advance forward in one complete rotation if it were moving through a solid medium. In water, slip causes the actual advance to be slightly less, but pitch remains a key design parameter for matching engine power to vessel speed.

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270. (A) I and II
Controllable pitch propellers allow the blade angle to be adjusted dynamically, enabling smooth shifting from forward to reverse without changing engine rotation or stopping the shaft. They are highly complex and expensive to maintain compared to fixed pitch propellers, but provide superior maneuverability during complex trawling operations.

271. (A) The areas of waterplanes and volumes of irregular ship hulls
Simpson's Rules are mathematical integration formulas used in naval architecture to calculate the areas of waterplanes and volumes of irregular displacement hulls. By dividing the hull profile into equal longitudinal intervals, these rules provide highly accurate approximations of buoyancy, displacement, and stability coefficients for vessel designs.

272. (A) The maximum legal draft to which the vessel can be safely loaded
The Plimsoll line is a marked symbol on a vessel's hull that indicates the maximum legal draft to which the boat can be safely loaded. This line is calculated based on reserve buoyancy and varies with water density and seasons, preventing overloading and protecting the vessel's stability.

273. (A) Longitudinal wash bulkheads (baffle plates) or pound boards
The free surface effect can be reduced in fish holds by installing longitudinal wash bulkheads or adjustable pound boards. These structures divide the large open hold into smaller compartments, which restricts the transverse sloshing of water or loose fish when the vessel rolls, maintaining the craft's static stability.

2015

10. Consider the following statements regarding sustainable fisheries management:

I. It requires maintaining target species at viable reproductive levels.

II. It focuses solely on maximizing short-term economic profit.

III. It involves mitigating adverse impacts on the surrounding ecosystem.

Which of the above statement(s) is/are correct?

(A) I and III
(B) I and II
(C) II and III
(D) I only

2024

11. What is a primary advantage of integrating traditional ecological knowledge with scientific fisheries management?

(A) It provides historical baselines and local ecosystem insights.
(B) It replaces the need for any quantitative stock assessment.
(C) It encourages unregulated open-access exploitation regimes.
(D) It solely maximizes the economic efficiency of modern gears.

2016

12. Which pair representing a management component and its primary function is incorrect?

(A) Catch quotas - Controlling total fishing mortality
(B) Gear restrictions - Improving size and species selectivity
(C) Subsidies - Directly decreasing overall fishing effort
(D) Closed seasons - Protecting spawning fish aggregations

2012

13. In fisheries stock assessment, the parameter 'fishing mortality' (F) is strictly defined as:

(A) Death of fish from predation and disease.
(B) Rate of fish migration from the zone.
(C) Fish death from senescence and competition.
(D) Rate of fish removal by fishing activities.

2024

14. The von Bertalanffy equation is an essential biological model primarily used to determine which parameter?

(A) Natural mortality coefficient
(B) Fishing gear selectivity ogives
(C) Somatic growth rate over time
(D) Maximum Economic Yield

2002

15. Which specific parameter is fundamentally excluded from a basic dynamic pool model like Beverton-Holt?

(A) Individual growth rate
(B) Market demand and pricing
(C) Natural mortality rate
(D) Age at first capture

2011

16. An arbitrary increase in natural mortality (M) while fishing mortality (F) remains constant will mathematically cause:

(A) Higher overall standing stock biomass
(B) Decreased total mortality (Z)
(C) Increased maximum theoretical length
(D) Reduced yield per recruit

2006

17. Which statement accurately describes Catch Per Unit Effort (CPUE) in assessment models?

(A) It is heavily utilized as a relative index of stock abundance.
(B) It always remains perfectly constant regardless of stock size.
(C) It is unaffected by technological improvements in gear efficiency.
(D) It directly measures the absolute total biomass of the stock.

2017

18. Essential basic parameters required for executing age-structured stock assessments include all of the following EXCEPT:

(A) Age at first maturity
(B) Age-specific catch data
(C) Global ocean current speeds
(D) Natural mortality rate

2021

19. If independent acoustic surveys show steeply declining biomass but commercial CPUE remains completely steady, managers should initially suspect:

(A) Hyperstability within the fishery data
(B) Hyperdepletion within the fishery data
(C) Drastically decreased gear efficiency
(D) Unprecedented increases in natural recruitment

2019

20. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): Virtual Population Analysis (VPA) calculates historical stock numbers based

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sequentially on past catches.
Reason (R): VPA relies heavily on precise predictions of future recruitment trends to calculate past numbers.
In the light of the above statements, choose the most appropriate answer from the options given below:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

21. 2013 The intrinsic rate of population increase (r) utilized in the Schaefer surplus production model fundamentally determines:
(A) The precise age and size of sexual maturity
(B) How quickly the population responds to depletion and recovers
(C) The individual length-weight relationship parameters
(D) The specific dietary preferences of the entire stock

22. 2006 Which statement regarding fundamental stock-recruitment relationships is incorrect?
(A) The Ricker model assumes declining recruitment at very high spawner densities.
(B) The Beverton-Holt model assumes an asymptote in recruitment levels.
(C) Recruitment is always directly and linearly proportional to spawning stock biomass.
(D) Recruitment variability is often driven significantly by environmental factors.

23. 2003 How does a holistic model (e.g., Schaefer) fundamentally differ in its data requirements from an analytical model (e.g., Beverton-Holt)?
(A) Holistic models require extensive individual stomach content analysis.
(B) Analytical models completely ignore the impacts of fishing effort.
(C) Analytical models treat the entire stock as a single un-structured unit of biomass.
(D) Holistic models do not strictly require age or size structure data.

24. 2018 Which stock assessment parameter is correctly paired with its standard mathematical symbol?
(A) Total Mortality - Z
(B) Natural Mortality - F
(C) Catchability coefficient - M
(D) Fishing Mortality - q

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25. 2004 Maximum Sustainable Yield (MSY) is theoretically defined as:
(A) The catch level that maximizes fleet profit margins
(B) The highest theoretical equilibrium yield continuously taken from a stock
(C) The absolute peak biomass a virgin stock can reach
(D) The lowest allowable catch to prevent localized extinction

26. 2017 Maximum Economic Yield (MEY) occurs exactly at the point where:
(A) Total revenue is perfectly equal to total operating cost.
(B) The net profit between total revenue and cost is maximized.
(C) Fishing effort is increased without causing recruitment failure.
(D) The marginal revenue equals zero across the entire fleet.

27. 2014 The reference point $F_{\{MSY\}}$ represents the specific rate of fishing mortality that:
(A) Eventually results in the Maximum Sustainable Yield
(B) Eradicates all mature spawning individuals
(C) Maximizes the economic rent of the harvesting fleet
(D) Represents the biological carrying capacity of the environment

28. 2014 Operating a fishery consistently beyond the Maximum Economic Yield (MEY) but below Maximum Sustainable Yield (MSY) will directly cause:
(A) Immediate biological collapse of the stock
(B) Unprecedented increases in fleet profitability
(C) Dissipation of potential economic rent
(D) Dramatic increases in virgin stock biomass

29. 2018 2019 Which of the following correctly describes the relationship between $B_{\{MSY\}}$ and virgin biomass (B_0) in standard surplus production models?
(A) $B_{\{MSY\}}$ is typically equal to B_0

(B) $B_{\{MSY\}}$ is typically twice the size of B_0
(C) $B_{\{MSY\}}$ is completely unrelated to B_0
(D) $B_{\{MSY\}}$ is typically around half of B_0

2015

30. Match the fisheries reference point in List I with its primary management focus in List II.
List I: (Reference Point)
P. MSY
Q. MEY
R. $B_{\{MSY\}}$
S. $F_{\{0.1\}}$
List II: (Management Focus)
1. Target biomass level for maximum yield
2. Conservative biological target based on marginal yield
3. Peak continuous physical harvest
4. Peak economic profit
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-1, Q-2, R-3, S-4
(D) P-2, Q-1, R-4, S-3

2006

31. Reference points are categorized as targets or limits. All of the following are generally considered limit reference points EXCEPT:
(A) $B_{\{\text{lim}\}}$
(B) $F_{\{tar \geq t\}}$
(C) $F_{\{crash\}}$
(D) Minimum biologically acceptable biomass

2010

32. Heavy government fuel subsidies typically shift the bioeconomic equilibrium of an open-access fishery, causing:
(A) Fishing effort to reduce closer to MEY
(B) The natural carrying capacity to immediately increase
(C) The stock to stabilize at virgin biomass levels
(D) Fishing effort to expand further beyond MEY and MSY

2012

33. Which statement regarding the classical assumptions of MSY is incorrect?
(A) It assumes multi-species interactions are the primary driver of yield.
(B) It assumes a steady state environment without extreme fluctuations.
(C) It assumes population growth responds predictably to density reduction.
(D) It treats the stock as a single independent biological unit.

2024

34. What is the best explanation for why the effort required to reach MEY is lower than the effort required to reach MSY?
(A) Fish are physically smaller at MEY than they are at MSY.
(B) Operating costs do not exist until the MSY level is reached.
(C) Cost of extra effort exceeds revenue of the extra catch.
(D) MEY relies entirely on recreational fishing methods.

2018

35. If a comprehensive stock assessment indicates that current biomass (B) is significantly less than $B_{\{MSY\}}$, managers can infer that:
(A) The stock is mathematically overfished.
(B) The stock is underexploited and effort should increase.
(C) The stock is at its maximum carrying capacity.
(D) The fishery is currently maximizing economic rent.

2019

36. What is a major advantage of using the $F_{\{0.1\}}$ reference point instead of $F_{\{\text{max}\}}$ in yield-per-recruit management?
(A) It completely eliminates the need to estimate natural mortality.
(B) It mathematically guarantees maximum total catch weight.
(C) It strictly applies only to highly migratory pelagic species.
(D) It provides a more conservative buffer against overfishing.

2016

37. Growth overfishing specifically occurs when:
(A) The spawning biomass is depleted below replacement levels.
(B) Fish are harvested at too small a size before reaching optimal growth.
(C) Fishing fleets exceed their economic operational budgets.
(D) Bycatch species are discarded dead at sea.

2014

38. Recruitment overfishing is primarily characterized by:
(A) Excessive capture of immature juveniles only.
(B) Overcapitalization of the fishing fleet infrastructure.
(C) Reduction of the adult population to a point

NODIA

where reproduction is impaired.
(D) Using highly selective gear that avoids spawning adults.

2013

39. Fishing fleet overcapacity is best described as a situation where:
(A) Vessel holds are too small to carry the daily catch.
(B) The available fish stock vastly exceeds the harvesting capability.
(C) Fishing effort is drastically lower than MSY requirements.
(D) The fleet's harvesting capability significantly exceeds the sustainable yield of the stock.

2004

40. Consider the following statements regarding the indicators of recruitment overfishing:
I. A sharp decline in the spawning stock biomass.
II. A sequence of very poor year-classes entering the fishery.
III. An increase in the average size of fish caught.
IV. A contraction of the stock's geographic range.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) II, III and IV
(C) I and III
(D) I, II, III and IV

2002

41. Which of the following directly exacerbates fishing fleet overcapacity on a global scale?
(A) Unrestricted vessel construction subsidies
(B) Strict implementation of individual transferable quotas
(C) Comprehensive elimination of open-access regimes
(D) Mandatory reductions in vessel engine horsepower

2008

42. A sudden, widespread reduction in codend mesh sizes across a trawl fleet will most likely cause:
(A) Immediate eradication of recruitment overfishing
(B) A decrease in the catch of juvenile fish
(C) A rapid onset or worsening of growth overfishing
(D) Increased long-term maximum sustainable yield

2006

43. All of the following are strong biological indicators that a stock is suffering from severe overfishing EXCEPT:
(A) Drastic truncation of the age structure
(B) Sustained declines in Catch Per Unit Effort (CPUE)
(C) Declining mean length of the catch
(D) Consistently high proportions of mature, large individuals in the catch

2005

44. What is the most direct regulatory application to mitigate growth overfishing in a specific targeted fishery?
(A) Increasing government fuel subsidies
(B) Mandating larger minimum mesh sizes for gears
(C) Allowing year-round unrestricted access
(D) Encouraging the harvest of apex predators

2004

45. Which definition regarding overcapacity in fisheries is incorrect?
(A) Overcapacity means vessels catch exactly the MSY using optimal economic inputs.
(B) Overcapacity leads to excessive pressure on regulatory enforcement.
(C) Overcapacity often results in shortened fishing seasons.
(D) Overcapacity represents a severe misallocation of economic capital.

2011

46. What is the best method to distinguish biologically between growth overfishing and recruitment overfishing?
(A) Monitoring fuel consumption of the fleet over time
(B) Counting the total number of registered fishing vessels
(C) Evaluating the price per kilogram of fish in global markets
(D) Assessing whether yield-per-recruit or spawning-stock-biomass is primarily impaired

2022

47. A manager observing severe overcapitalization in a fishery can correctly infer that:
(A) The resource rent is being completely maximized.
(B) The stock is highly likely to remain unexploited.
(C) Economic waste is occurring due to redundant fishing effort.

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(D) Biological sustainability is mathematically guaranteed.

2011

48. What is a recognized disadvantage of poorly designed vessel buyback programs intended to reduce overcapacity?
(A) Remaining vessels may increase their individual effort, negating capacity reduction.
(B) They instantly cause recruitment overfishing.
(C) They permanently eliminate all fishing knowledge from communities.
(D) They decrease the natural mortality rate of the stock.

2009

49. Ghost fishing is technically defined as:
(A) The illegal harvest of fish during night hours without lights.
(B) The continued catching of marine life by lost or abandoned fishing gear.
(C) The deliberate discarding of unmarketable fish at sea.
(D) The use of invisible monofilament lines by recreational anglers.

2011

50. Select the correct sequence describing the typical ecological cycle of ghost fishing in lost traps/pots.
(A) Bait exhaustion → Gear disintegration → Peak catching → Scavenger entry
(B) Initial bait attracts catch → Catch dies and becomes bait → Cyclic continuous capture → Eventual gear degradation
(C) Gear degradation → Initial bait attracts catch → Cyclic continuous capture → Catch dies
(D) Scavenger entry → Cyclic continuous capture → Initial bait attracts catch → Gear degradation

2007

51. Which type of fishing gear is globally recognized as producing the highest mortality rates through ghost fishing?
(A) Handlines and pole-and-line
(B) Bottom-set gillnets and traps
(C) Surface trolling lines
(D) Harpoons and spears

2018

52. The accumulation of dead catch in a ghost-fishing gillnet typically causes which physical effect on the gear?
(A) It increases the net's buoyancy, bringing it to the surface.
(B) It strengthens the synthetic fibers, increasing longevity.
(C) It causes the net to become heavier and collapse to the seafloor, temporarily halting fishing.
(D) It rapidly dissolves the leadlines, scattering the net.

2025

53. Which of the following is a recognized technical mitigation strategy specifically designed to prevent trap-based ghost fishing?
(A) Installing biodegradable escape panels or hinges
(B) Using heavier, non-degradable synthetic ropes
(C) Increasing the number of traps deployed per vessel
(D) Removing all surface marker buoys

2006

54. All of the following are primary causes of gear loss leading to ghost fishing EXCEPT:
(A) Extreme adverse weather conditions
(B) Interactions with marine mammals or sharks
(C) Gear conflicts with active towed gears (e.g., trawlers severing lines)
(D) Strict adherence to spatial marine protected areas

NODIA

2024

55. A fisheries manager implementing a mandatory gear marking system is applying a strategy primarily intended to:
(A) Increase the sinking speed of gillnets
(B) Trace lost gear back to owners to enforce accountability and recovery
(C) Maximize the camouflage of the gear underwater
(D) Prevent gear from degrading in saltwater

2022

56. Which statement regarding the materials involved in ghost fishing is incorrect?
(A) Synthetic materials like nylon resist degradation for decades.
(B) Natural fiber nets lose their catching efficiency much faster than synthetic ones.
(C) Biodegradable twine completely prevents gear from ever being lost.
(D) Modern plastics have drastically increased the severity of ghost fishing.

(C) II, I, IV, III
(D) IV, II, I, III

2016

112. Chronic IUU fishing directly causes which severe problem for fisheries scientists?
(A) It drastically increases the accuracy of Virtual Population Analysis.
(B) It introduces massive bias into catch statistics, invalidating stock assessments.
(C) It physically forces all fish to migrate out of the EEZ.
(D) It causes an immediate drop in marine microplastics.

2006

113. The practice of registering a fishing vessel in a country with lax enforcement to avoid strict regulations is correctly termed using:
(A) Flags of convenience
(B) Ecosystem-based management
(C) Territorial Use Rights for Fishing
(D) Eco-labeling certification

2022

114. All of the following are explicit examples of IUU fishing EXCEPT:
(A) Fishing inside a strictly enforced Marine Protected Area
(B) Using prohibited gears like explosives or poisons
(C) Harvesting exact quota limits as prescribed by the management authority
(D) A vessel from a non-RFMO state fishing in the RFMO's regulated high seas

2023

115. A fisheries management body mandates the installation of VMS on all industrial vessels. This is a technical application primarily designed to:
(A) Enhance the growth rate of target species
(B) Continuously track vessel location to monitor spatial compliance
(C) Reduce the physical weight of the trawl net
(D) Automatically sort the catch by size on deck

2013

116. Which statement regarding the drivers of IUU fishing is incorrect?
(A) IUU fishing is heavily driven by high economic value and demand for certain species.
(B) Weak governance and lack of surveillance resources exacerbate IUU fishing.
(C) Overcapacity in legitimate fleets can push marginalized vessels into IUU activities.
(D) IUU operators carefully ensure they pay all required national taxes and tariffs.

2005

117. What is the best international legal instrument specifically designed to prevent illegally caught fish from entering international markets?
(A) The FAO Port State Measures Agreement (PSMA)
(B) The Paris Agreement on Climate Change
(C) The Kyoto Protocol
(D) The Geneva Convention

2023

118. Based on MCS constraints, one can logically infer that daily operations within artisanal, small-scale sectors are often more difficult to regulate than industrial sectors because:
(A) Artisanal vessels are entirely immune to all national maritime laws.
(B) Artisanal fleets consist of numerous dispersed vessels landing at remote sites.
(C) Artisanal fishers exclusively use highly visible industrial factory trawlers.
(D) Artisanal catch is never sold or consumed.

2014

119. What is a primary advantage of comprehensive Catch Documentation Schemes (CDS)?
(A) They trace fish from the point of capture to the final market, denying market access to IUU fish.
(B) They strictly dictate the size of the mesh used in the fishery.
(C) They completely replace the need for any physical at-sea patrols.
(D) They inherently increase the total allowable catch (TAC) limits.

2014

120. Consider the following factors associated with IUU fishing:
I. Lack of political will and corruption.
II. High operational costs of legal fishing combined with high market prices.
III. Comprehensive 100% observer coverage on all vessels.
IV. Vast, unpatrolled expanses of exclusive economic zones.
Which of the above are recognized drivers that increase the prevalence of IUU fishing?
(A) I, II, and IV
(B) III only
(C) II and IV
(D) I and II

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trophic cascade

2013

67. A manager implements controlled artificial floods from a dam during the monsoon season. This application aims to:
(A) Permanently drain downstream wetlands
(B) Maximize hydroelectric power generation exclusively
(C) Prevent the degradation of biodegradable fishing gear
(D) Mimic natural hydrological cues to trigger fish spawning migrations

2004

68. Which statement contradicts the River Continuum Concept regarding anthropogenic alterations?
(A) Habitat modifications have zero impact on benthic macroinvertebrate functional groups.
(B) Dams reset the continuum by trapping organic matter.
(C) Flow regulation disrupts predictable downstream biological shifts.
(D) Riparian deforestation alters natural shading and energy inputs.

2021

69. What is the best description of how reduced freshwater discharge due to dams impacts downstream estuarine fisheries?
(A) It drastically increases estuarine turbidity, promoting visual predators.
(B) It causes hypersalinity and alters nursery habitat suitability for euryhaline species.
(C) It permanently converts the estuary into a strictly freshwater environment.
(D) It accelerates the growth rate of all marine pelagic species.

2012

70. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Large dams significantly reduce the transport of sediments and nutrients to coastal waters.
Reason (R): Decreased nutrient delivery leads to enhanced coastal primary productivity and higher fisheries yields.
In the light of the above statements, choose the most appropriate answer from the options given below:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2016

71. From the isolation of floodplain wetlands (beels) due to flood-control embankments, one can infer that:
(A) Auto-stocking from the main river will be severely impaired or stopped.
(B) The genetic diversity of the wetland fish will immediately double.
(C) The water quality in the wetland will remain pristine forever.
(D) Rheophilic species will thrive in the isolated wetland.

2009

72. What is a primary disadvantage of strictly maintaining environmental flows (e-flows) in a highly regulated river?
(A) It ensures the survival of endemic fish species.
(B) It maintains downstream estuarine salinity gradients.
(C) It reduces the total volume of water available for agricultural irrigation and hydropower.
(D) It causes an uncontrollable explosion of invasive aquatic weeds.

2023

73. Ocean acidification is primarily defined by a decrease in oceanic pH caused by the absorption of anthropogenic:
(A) Carbon dioxide
(B) Sulfur dioxide
(C) Methane
(D) Nitrous oxide

NODIA

2002

74. Thermal shifts in the ocean due to global climate change generally force marine fish populations to:
(A) Migrate toward the equator
(B) Remain entirely stationary and rapidly mutate
(C) Migrate poleward or to deeper waters
(D) Migrate exclusively to freshwater estuaries

2021

75. A well-documented biological consequence of ocean acidification is the reduction of available carbonate ions, which directly impairs:
(A) The physical calcification process in mollusks

2006

57. Which gear type relies on the structural integrity of a "wall of webbing" and is thus highly susceptible to continuous ghost fishing when lost over reefs?
(A) Purse seine
(B) Pelagic longline
(C) Demersal longline
(D) Drift gillnet

2022

58. From an economic perspective, managers can accurately infer that ghost fishing primarily results in:
(A) Unquantified hidden mortality that distorts stock assessments and reduces future yields
(B) Increased market prices for all remaining active vessels
(C) Immediate reductions in government subsidies
(D) Enhanced catch rates for legal gears in the vicinity

2023

59. A significant disadvantage of replacing all synthetic fishing nets entirely with rapid-biodegradable materials is:
(A) Unprecedented increases in ghost fishing mortality
(B) Total elimination of bycatch
(C) Reduced gear strength and frequent need for replacement, increasing fisher costs
(D) Immediate legal violations of the UNCLOS treaty

2003

60. Consider the following mitigation measures for ghost fishing:
I. Mandatory gear marking
II. Use of acoustic pingers for marine mammal deterrent
III. Regular derelict gear recovery programs
IV. Global bans on all motorized fishing
V. Implementation of biodegradable escape panels
Which of the above are recognized practical measures specifically for mitigating ghost fishing?
(A) I, III, and V
(B) I, II, and III
(C) III, IV, and V
(D) IV only

2005

61. Anthropogenic habitat degradation in riverine systems is most frequently initiated by:
(A) Physical alterations like damming and channelization
(B) Catch-and-release recreational fishing
(C) Strict implementation of seasonal closures
(D) Deployment of biodegradable fishing gear

2022

62. River damming poses the most severe existential biological threat to which specific classification of fish?
(A) Pelagic highly migratory species
(B) Deep-sea demersal species
(C) Estuarine resident species
(D) Anadromous and catadromous migratory species

2019

63. River interlinking projects are most heavily criticized by fisheries ecologists due to the high risk of:
(A) Transferring alien invasive species and altering endemic aquatic biodiversity
(B) Completely stopping all water flow to the ocean
(C) Increasing the global Mean Trophic Level
(D) Reducing total aquatic surface area

2015

64. Drastic flow alteration and reduction in a river system will directly cause:
(A) Immediate elimination of all heavy metals in the water
(B) Enhancement of natural spawning cues for rheophilic species
(C) Decreased water temperatures in shallow reservoirs
(D) Reduced lateral connectivity with crucial floodplain wetlands

2013

65. Which engineering intervention is correctly identified as a primary mitigation tool for restoring longitudinal connectivity for fish?
(A) Turtle Excluder Devices
(B) Fish passes and ladders
(C) Embankment armoring
(D) Bycatch Reduction Devices

2011

66. All of the following are recognized ecological impacts of large-scale river damming EXCEPT:
(A) Alteration of natural thermal regimes downstream
(B) Trapping of crucial nutrient-rich sediments
(C) Conversion of lotic habitats into lentic habitats
(D) Immediate reversal of the marine food web

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(B) It causes the immediate reversal of ocean acidification.
(C) It increases fuel consumption, operational costs, and carbon footprints.
(D) It entirely eliminates the possibility of bycatch.

2015

85. Bycatch is formally defined as:
(A) The incidental capture of non-target species or undersized target species during fishing
(B) The deliberate targeting of non-commercial species
(C) The total weight of the legal catch brought to port
(D) Fish that escape through the meshes of a trawl net

2018

86. The portion of the catch that is returned to the sea, whether dead or alive, is specifically termed:
(A) Landings
(B) Incidental catch
(C) Discards
(D) Target catch

2019

87. Turtle Excluder Devices (TEDs) were originally developed and mandated primarily for use in which specific fishery?
(A) Pelagic longline fisheries
(B) Bottom gillnet fisheries
(C) Deep-sea pot fisheries
(D) Tropical shrimp trawl fisheries

2017

88. Unregulated bottom trawling with high discards frequently causes which ecological effect?
(A) Alteration of benthic communities, often favoring opportunistic scavengers
(B) Immediate proliferation of slow-growing, long-lived benthic species
(C) Complete elimination of all oceanic microplastics
(D) Significant enhancement of coral reef structural complexity

2009

89. Which correctly describes a common mechanical mechanism of a Bycatch Reduction Device (BRD)?
(A) Utilizing differences in behavior and swimming ability between shrimp and finfish
(B) Increasing the towing speed to outrun all non-target species
(C) Using purely chemical repellents to deter unwanted fish
(D) Reducing the overall size of the vessel engine

2022

90. Consider the following statements regarding bycatch and discards:
I. Discarding alters food web dynamics by heavily subsidizing marine scavengers.
II. Bycatch consists exclusively of marine mammals and sea turtles.
III. High discard rates are often driven by strict quota regulations and market preferences.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2016

91. All of the following gear types are heavily associated with technical Bycatch Reduction Device (BRD) implementation EXCEPT:
(A) Harpoons
(B) Otter trawls
(C) Beam trawls
(D) Shrimp trawls

2011

92. A fishery implements a mandatory TED regulation but continues to see high turtle mortality. What is the most likely application error?
(A) The bar spacing on the TED deflector grid is too narrow for shrimp.
(B) The trawl net is constructed entirely of biodegradable materials.
(C) The TED escape flap is sewn shut or obstructed by debris.
(D) The vessel is fishing exclusively in strictly pelagic zones.

2004

93. Which statement regarding bycatch management is incorrect?
(A) It is technologically possible to achieve zero bycatch in all commercial fisheries.
(B) Spatial-temporal closures are effective for avoiding bycatch hotspots.
(C) Circle hooks significantly reduce deep-hooking mortality in longline bycatch.
(D) Bycatch can include the juveniles of the targeted commercial species.

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oceans
2. Cod moving between Canada's EEZ and the adjacent high seas
3. Eels spawning in the ocean but growing in freshwater
4. Salmon growing in the ocean but spawning in freshwater

(A) P-1, Q-2, R-4, S-3
(B) P-2, Q-1, R-4, S-3
(C) P-4, Q-3, R-1, S-2
(D) P-2, Q-1, R-3, S-4

2008

131. From the difficulty of managing high seas fisheries, one can infer that these areas are highly susceptible to:
(A) The Tragedy of the Commons
(B) Hyperstability
(C) Extreme under-exploitation
(D) Immediate privatization through TURFs

2010

132. What is a distinct advantage of forming joint bilateral management bodies for shared riverine fish stocks?
(A) It allows upstream countries to unilaterally dam rivers without notice.
(B) It completely isolates the fish populations to specific national zones.
(C) It facilitates harmonized regulations and unified stock assessments across the entire watershed.
(D) It inherently prevents all forms of recreational fishing.

2008

133. The FAO Code of Conduct for Responsible Fisheries (CCRF) is legally defined globally as:
(A) A strictly binding international treaty with heavy financial penalties
(B) A mandatory annex of the Geneva Convention
(C) An exclusive agreement applicable only to developing nations
(D) A voluntary framework guiding national and international fisheries policies

2021

134. In which year was the FAO Code of Conduct for Responsible Fisheries (CCRF) unanimously adopted?
(A) 1982
(B) 1995
(C) 2001
(D) 2015

2013

135. Article 7 of the FAO CCRF is specifically dedicated to establishing guidelines for:
(A) Aquaculture development
(B) Post-harvest practices and trade
(C) Fisheries management frameworks and principles
(D) Integration of fisheries into coastal area management

2004

136. The widespread implementation of the CCRF's technical guidelines by a nation is most likely to cause:
(A) An alteration of fishing fleet overcapacity
(B) Improved alignment of national legislation with global sustainability standards
(C) An immediate withdrawal from all RFMOs
(D) The absolute prohibition of all artisanal fishing gears

2003

137. Which concept is strongly advocated by the FAO CCRF as a central tenet for decision-making under uncertainty?
(A) The Precautionary Approach
(B) The Maximum Extraction Rule
(C) The Open Access Paradigm
(D) The Biotic Homogenization Principle

2003

138. The comprehensive scope of the FAO CCRF covers all of the following sectors EXCEPT:
(A) Capture fisheries management
(B) Inland aquaculture and coastal mariculture
(C) International trade and post-harvest utilization
(D) Military naval operations in the EEZ

2021

139. A government passes a law requiring strict hygiene standards and ice-storage facilities at all fish landing sites. This directly applies guidelines from the CCRF article concerning:
(A) Post-harvest practices and trade
(B) Fishing operations
(C) Aquaculture development
(D) Fisheries research

2019

140. Consider the following core principles found in the FAO CCRF:
I. Prevention of overfishing and excess capacity.
II. Protection of critical fisheries habitats.
III. Promotion of destructive fishing practices to maximize yield.

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temperature
(C) The complete cessation of all local commercial fishing
(D) The mass extinction of hundreds of endemic haplochromine cichlid species

2006
103. All of the following represent potential negative impacts of invasive species EXCEPT:
(A) Trophic disruption and predation on native species
(B) Introduction of novel aquatic pathogens
(C) Competitive exclusion of indigenous fauna
(D) Enhanced genetic integrity of endemic populations

2013
104. A manager applies a chemical piscicide to an isolated pond to remove an invasive snakehead population. This eradication approach is heavily limited in open river systems because:
(A) Piscicides are completely harmless to native species.
(B) Snakeheads are entirely immune to all known chemicals.
(C) It is impossible to contain the chemical, leading to massive non-target native mortality.
(D) The chemical strictly causes biotic homogenization.

2009
105. Which statement regarding exotic aquatic species is incorrect?
(A) All exotic species eventually become highly invasive and destructive.
(B) Some exotic species are introduced intentionally for aquaculture.
(C) Invasive species can severely alter local nutrient cycling.
(D) Eradicating an established marine invasive species is virtually impossible.

2025
106. What is the best preventative management action against the escape of invasive species from aquaculture facilities?
(A) Constructing facilities entirely in open-ocean floating cages
(B) Utilizing massive doses of antibiotics
(C) Releasing a secondary exotic predator to control escapes
(D) Implementing strict biosecurity protocols and using sterile triploid fish

2018
107. From the widespread use of exotic species in aquaculture, one can infer a significant risk of:
(A) Immediate localized sea-level rise
(B) Genetic introgression if the exotics are closely related to wild native stocks
(C) Complete eradication of ocean acidification
(D) Automatic compliance with the FAO Code of Conduct

2012
108. What is a critical disadvantage of intentionally introducing an exotic species for the biocontrol of aquatic weeds?
(A) It eliminates the need for manual weed harvesting.
(B) It perfectly restores the original virgin biomass of the ecosystem.
(C) It inherently violates all principles of Maximum Sustainable Yield.
(D) The exotic species might shift its diet to consume valuable native flora or fauna.

2004
109. Under the FAO definition, what does the "U" in IUU fishing stand for alongside "Unregulated"?
(A) Unreported
(B) Unrestricted
(C) Unlicensed
(D) Unmonitored

2006
110. Which activity specifically constitutes "Unreported" fishing?
(A) Misreporting catch data, such as under-declaring weight or species, to national authorities
(B) Fishing in an area covered by an RFMO without being a member
(C) Fishing completely outside any national or international jurisdiction
(D) Using highly selective and legal fishing gears

2025
111. Arrange the following Monitoring, Control, and Surveillance (MCS) implementation steps in their logical operational order:
I. Deployment of patrol vessels for inspection
II. Registration and licensing of the fishing vessel
III. Prosecution and sanctioning of violations
IV. Electronic monitoring via VMS during fishing
Which option shows the correct arrangement?
(A) I, II, III, IV
(B) II, IV, I, III

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2002

94. What is the most direct biological reason for replacing diamond mesh with square mesh in trawl codends?

(A) Square mesh remains open under tension, allowing better escapement of undersized fish.
(B) Square mesh completely prevents the entry of marine mammals.
(C) Square mesh traps more sediment, increasing the net's weight.
(D) Square mesh dissolves rapidly in saltwater, preventing ghost fishing.

2022

95. From studies on discard mortality, managers can infer that surviving a trawl capture and subsequent discard heavily depends on:

(A) The phase of the lunar cycle
(B) Air exposure time, catch volume, and thermal stress on deck
(C) The total volume of subsidies provided to the vessel
(D) The color of the vessel's hull

2006

96. What is a notable disadvantage of implementing mandatory "no-discard" (landing obligation) policies?

(A) They force vessels to halt fishing early if their holds fill with low-value choke species.
(B) They inherently increase the natural mortality rate of fish.
(C) They completely eliminate the need for any BRDs.
(D) They encourage the widespread use of explosives in fishing.

2013

97. An invasive aquatic species is formally defined as an introduced species that:

(A) Originates from a different continent but dies quickly in the new environment.
(B) Establishes itself, spreads rapidly, and causes ecological or economic harm.
(C) Is selectively bred in hatcheries for human consumption.
(D) Exists strictly within its historical native range.

2017

98. The most common vector for the accidental introduction of marine invasive species globally is:

(A) Recreational aquarium release
(B) Attachment to the feathers of migratory seabirds
(C) Discharge of ship ballast water
(D) Intentional stocking for fisheries enhancement

NODIA

2001

99. Biotic homogenization in aquatic ecosystems refers specifically to:

(A) The replacement of unique local biotas with widespread, often invasive, species.
(B) The process of increasing distinct endemic biodiversity globally.
(C) The uniform distribution of fishing effort across all oceans.
(D) The mixing of fresh and marine waters in an estuary.

2005

100. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): The introduction of predatory exotic fish often leads to the rapid decline or extinction of native endemic species.

Reason (R): Native species typically lack evolutionary adaptations to evade novel introduced predators.

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2023

101. Which scenario strictly represents an accidental introduction of an aquatic exotic species?

(A) Larvae transported across oceans via hull fouling on commercial ships
(B) Stocking tilapia in a closed reservoir for local food security
(C) Releasing hatchery-reared native salmon to enhance local stocks
(D) Government-led introduction of mosquitofish for biocontrol

2014

102. The introduction of the Nile perch into Lake Victoria directly caused which catastrophic ecological effect?

(A) The immediate eradication of all aquatic vegetation
(B) A drastic decrease in the overall water

2001

121. Straddling fish stocks are legally defined under UNCLOS as stocks that:
(A) Remain entirely within the territorial waters of a single state
(B) Occur both within an Exclusive Economic Zone (EEZ) and in an adjacent high seas area
(C) Migrate exclusively across the deep abyssal plains
(D) Consist purely of anadromous species like salmon

2006

122. Highly migratory species, as listed in Annex I of UNCLOS, prominently include:
(A) Sedentary coral species
(B) Coastal mangrove crabs
(C) Tunas and oceanic sharks
(D) Freshwater carps

2002

123. The primary international bodies responsible for coordinating the management of transboundary and highly migratory fish stocks are:
(A) Local municipal councils
(B) Non-Governmental Environmental Charities
(C) National Coast Guards
(D) Regional Fisheries Management Organizations (RFMOs)

2001

124. Uncoordinated management of a shared transboundary stock by two adjacent countries will inevitably cause:
(A) Overexploitation, as each nation races to maximize its own unilateral catch
(B) An immediate doubling of the stock's carrying capacity
(C) Perfect achievement of Maximum Economic Yield
(D) Strict adherence to EBFM principles

2025

125. The 1995 UN Fish Stocks Agreement (UNFSA) specifically operationalized provisions for which categories of fish?
(A) Straddling fish stocks and highly migratory fish stocks
(B) Freshwater and strictly coastal demersal stocks
(C) Estuarine and wetland endemic stocks
(D) Deep-sea hydrothermal vent communities

2008

126. All of the following are generally managed as highly migratory or straddling transboundary stocks EXCEPT:
(A) Atlantic Bluefin Tuna
(B) Oceanic Whitetip Shark
(C) Endemic lake cichlids
(D) Jack Mackerel in the South Pacific

2009

127. An RFMO assigns catch limits for a specific tuna stock to member countries based on historical catch. This is an application of:
(A) Quota allocation
(B) Open access management
(C) Marine Protected Area creation
(D) Biotic homogenization

2016

128. Which statement regarding the legal frameworks of transboundary stocks is incorrect?
(A) A coastal state claims exclusive sovereign ownership over highly migratory fish even when they enter the high seas.
(B) Coastal states have sovereign rights to manage stocks strictly within their EEZ.
(C) States fishing for straddling stocks on the high seas must cooperate with adjacent coastal states.
(D) UNCLOS provides the overarching foundational framework for maritime jurisdiction.

2021

129. What is the most significant challenge regarding RFMO compliance?
(A) They strictly possess international police forces that are too aggressive.
(B) They manage stocks that never cross any international boundaries.
(C) They are legally forbidden from conducting any scientific research.
(D) They rely on voluntary compliance and lack robust enforcement.

2017

130. Match the transboundary/migratory category in List I with the correct description or example in List II.
List I: (Category)
P. Straddling stock
Q. Highly migratory species
R. Anadromous stock
S. Catadromous stock
List II: (Description)
1. Tunas crossing multiple EEZs and open

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and corals
(B) The visual acuity of pelagic predators
(C) The swimming speed of anadromous fishes
(D) The biodegradation of synthetic fishing nets

2002
76. Increased sea surface temperatures are most likely to cause which effect on tropical fish stocks?
(A) Increased maximum body size due to higher dissolved oxygen
(B) Enhanced survival rates of cold-water pathogens
(C) Immediate shifts to lower trophic level diets
(D) Reduced reproductive success and localized extinctions

2023
77. Which statement correctly identifies a secondary fisheries impact of coral bleaching driven by thermal stress?
(A) Bleached corals release excessive nutrients that double fish growth rates.
(B) Decreased structural complexity reduces habitat for reef-associated reef fish.
(C) The lack of zooxanthellae directly poisons all herbivorous fishes.
(D) Bleaching completely stops all ocean acidification processes.

2018
78. All of the following are highly probable impacts of climate change on fisheries EXCEPT:
(A) Alteration of oceanic current patterns
(B) Changes in the timing of plankton blooms
(C) Increased frequency of extreme weather events disrupting fishing operations
(D) Global reduction in Illegal, Unreported, and Unregulated (IUU) fishing

2019
79. A Regional Fisheries Management Organization (RFMO) modifies historical quota allocations because a target stock has shifted into a new national jurisdiction. This is an application of adapting to:
(A) Geographic stock redistribution driven by climate change
(B) Recruitment overfishing
(C) Ghost fishing impacts
(D) Marine pollution regulations

2019
80. Match the climate change stressor in List I with its primary biological impact in List II.
List I: (Stressor)
P. Ocean acidification
Q. Sea surface warming
R. Sea level rise
S. Oceanic deoxygenation
List II: (Impact)
1. Habitat compression for active pelagic predators
2. Degradation of coastal mangrove nursery habitats
3. Dissolution of pteropod shells
4. Poleward shift of species ranges
(A) P-3, Q-4, R-2, S-1
(B) P-4, Q-3, R-1, S-2
(C) P-1, Q-2, R-3, S-4
(D) P-2, Q-1, R-4, S-3

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2012
81. Which statement regarding climate change and fisheries is incorrect?
(A) Warming waters possess a higher capacity to hold dissolved oxygen.
(B) Phenological mismatches occur when larval fish and their zooplankton prey peak at different times.
(C) Climate change alters the distribution of highly migratory species.
(D) Ocean acidification threatens the base of marine food webs.

2008
82. What is the most appropriate proactive management strategy to address shifting fish stocks due to thermal changes?
(A) Completely banning all fishing globally
(B) Implementing rigid, static marine protected areas that never change boundaries
(C) Utilizing dynamic ocean management and flexible spatial closures
(D) Subsidizing the construction of massive coastal seawalls

2011
83. From current climate projections, scientists infer that fisheries in which geographic zone are most highly vulnerability to severe catch declines?
(A) Tropical developing nations
(B) Arctic regions
(C) High-latitude temperate zones
(D) Deep-sea hydrothermal vents

2016
84. What is a disadvantage of shifting fleet operations to follow thermally migrating fish stocks?
(A) It strictly ensures the recovery of coral reef habitats.

IV. Application of the precautionary approach.
V. Recognition of the nutritional rights of local communities.

Which of the above statement(s) are correct principles of the CCRF?

(A) I, II, IV, and V
(B) I, IV, and V
(C) II, III, and V
(D) I, II, and III

2019

141. Which statement about the FAO CCRF is incorrect?

(A) It forces non-compliant nations to pay mandatory financial reparations.
(B) It incorporates the principles of the UN Fish Stocks Agreement.
(C) It addresses both environmental protection and socio-economic equity.
(D) It encourages energy-efficient and highly selective fishing gears.

2006

142. What is the most accurate description of how the CCRF addresses developing countries?

(A) It strictly exempts them from all conservation measures.
(B) It highlights the need for capacity building and financial support to aid their compliance.
(C) It strictly bans them from operating any industrial vessels.
(D) It demands they immediately privatize all their territorial waters.

2022

143. Based on its voluntary nature, one can infer that the true effectiveness of the CCRF entirely depends upon:

(A) The deployment of FAO armed patrol vessels on the high seas.
(B) Total global elimination of all commercial seafood trade.
(C) Its integration into the binding domestic laws of individual states.
(D) The rapid expansion of unregulated high seas fleets.

2003

144. A major disadvantage of the CCRF relying strictly on a voluntary framework is:

(A) States can adopt specific portions while ignoring difficult measures.
(B) It completely overrides all existing national sovereignties.
(C) It inherently forces nations into armed conflict over fish.
(D) It actively promotes Illegal, Unreported, and Unregulated (IUU) fishing.

2010

145. In fisheries, traceability is defined as the ability to:

(A) Accurately predict the future biomass of a stock
(B) Track the movement of seafood products through all stages of the supply chain
(C) Trace the specific genetic mutations of an exotic species
(D) Map the entire topography of the ocean floor

2002

146. To achieve robust eco-labeling certification, a fishery must strictly maintain a verifiable:

(A) Ghost fishing network
(B) Chain of Custody
(C) Tragedy of the Commons
(D) Fleet overcapacity register

2023

147. The Marine Stewardship Council (MSC) certification strictly requires fisheries to demonstrate compliance with:

(A) Absolute zero fishing mortality across the entire marine ecosystem.
(B) Sustainable stocks, minimized impact, and effective management.
(C) Maximum fleet overcapitalization to ensure industrial efficiency.
(D) Mandatory use of strictly traditional, unmotorized vessels

2013

148. Securing a recognizable eco-label (like MSC) often causes which economic effect for the compliant fishery?

(A) Access to premium markets and potentially higher price margins
(B) Immediate bankruptcy due to certification costs
(C) Complete collapse of market demand
(D) Mandatory government taxation on all catch

2013

149. Which correctly identifies the three core pillars of the MSC fisheries standard?

(A) High yield, low cost, open access
(B) Stock sustainability, ecosystem impact, and effective governance
(C) Maximum bycatch, unlimited quota, minimal research
(D) Government subsidies, private ownership,

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closed markets

2002

150. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Comprehensive seafood traceability systems drastically reduce the prevalence of IUU fishing.
Reason (R): Traceability systems require verifiable documentation that prevents illegal catch from blending with legal catch in the supply chain.
In the light of the above statements, choose the most appropriate answer from the options given below:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2008

151. All of the following are modern tools used directly to ensure seafood traceability EXCEPT:
(A) Catch certificates and logbooks
(B) RFID tags and blockchain technology
(C) Biological yield-per-recruit models
(D) DNA testing and forensic species identification

2007

152. A regulatory body uses rapid DNA barcoding at a retail market to verify a product labeled as "Atlantic Cod." This is an application primarily addressing:
(A) Seafood fraud and mislabeling
(B) The direct calculation of Total Allowable Catch
(C) Vessel navigation strictly within the EEZ
(D) The elimination of ghost fishing

2009

153. Which statement regarding seafood eco-labeling is incorrect?
(A) Eco-labels mathematically guarantee that the certified fishery causes zero mortality to any marine organism.
(B) Eco-labeling harnesses consumer purchasing power to incentivize sustainable practices.
(C) The certification process is often rigorous, lengthy, and expensive.
(D) Chain of custody ensures certified fish are not mixed with uncertified fish during processing.

2009

154. What is the most significant socioeconomic benefit of traceability frameworks for local coastal states?
(A) It protects local fishers from unfair competition with illegal imports.
(B) It strictly ensures fish are only consumed by the fishermen themselves.
(C) It removes the requirement to perform biological stock assessments.
(D) It inherently maximizes the physical size of the vessels.

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2008

155. From the high financial costs of MSC assessment, one can infer a significant barrier for:
(A) Massive multinational industrial trawling fleets
(B) Data-rich, government-funded fisheries
(C) Small-scale, data-poor artisanal fisheries in developing nations
(D) Inland closed-system aquaculture farms

2010

156. A notable disadvantage of relying heavily on consumer-driven eco-labeling for global sustainability is:
(A) It entirely replaces the need for any governmental laws.
(B) It strictly applies only to deep-sea benthic organisms.
(C) It is largely ineffective in markets where consumers prioritize low price over environmental concerns.
(D) It causes the immediate collapse of the marine food web.

2018

157. Under the United Nations Convention on the Law of the Sea (UNCLOS), the Exclusive Economic Zone (EEZ) typically extends up to:
(A) 200 nautical miles from the baseline
(B) 12 nautical miles from the baseline
(C) 24 nautical miles from the baseline
(D) 350 nautical miles from the baseline

2001

158. Species listed under Appendix II of the Convention on International Trade in Endangered Species (CITES) are characterized as:
(A) Species threatened with imminent extinction, with commercial trade strictly prohibited.
(B) Species not necessarily threatened with extinction, but whose trade must be strictly

controlled to avoid overutilization.
(C) Species protected entirely at the request of a single specific country.
(D) Species that are completely unregulated and open to all global markets.

2015
159. The primary legal objective of the UNFSA (UN Fish Stocks Agreement) is to:
(A) Ensure the long-term conservation and sustainable use of straddling and highly migratory fish stocks
(B) Dictate the exact mesh sizes for all trawl nets globally
(C) Fully privatize the High Seas under corporate ownership
(D) Ban the trade of all marine mammals

2021
160. Match the international agreement in List I with its primary regulatory focus in List II.
List I: (Agreement)
P. UNCLOS
Q. UNFSA
R. CITES
S. FAO CCRF
List II: (Regulatory Focus)
1. Voluntary guidelines for holistic responsible fishing
2. Regulating international trade of endangered species
3. Foundational framework for maritime zones and EEZ rights
4. Binding management rules for straddling and migratory stocks
(A) P-3, Q-4, R-2, S-1
(B) P-4, Q-3, R-1, S-2
(C) P-3, Q-2, R-4, S-1
(D) P-1, Q-4, R-2, S-3

2004
161. Under UNCLOS, the legal concept of "Freedom of the High Seas" regarding fishing means that:
(A) Nationals may fish subject to treaty obligations and conservation duties.
(B) Any vessel can fish anywhere without any rules or restrictions whatsoever.
(C) High seas fishing is strictly prohibited to all sovereign nations.
(D) Only landlocked countries are permitted to fish in international waters.

2002
162. The universal establishment of 200-nautical-mile EEZs under UNCLOS historically caused:
(A) The immediate end of all IUU fishing globally.
(B) A complete halt to the construction of modern fishing vessels.
(C) A massive transfer of marine resource control from open-access international status to coastal state jurisdiction.
(D) The rapid expansion of international distant-water fleets without any regulation.

2009
163. All of the following are explicit provisions or obligations under UNCLOS regarding fisheries EXCEPT:
(A) Coastal states must determine the allowable catch in their EEZ.
(B) Coastal states must promote the objective of optimum utilization of living resources.
(C) Coastal states must ensure living resources are not endangered by over-exploitation.
(D) Coastal states must grant adjacent landlocked states ownership of their ports.

2007
164. CITES lists the Oceanic Whitetip Shark on Appendix II. This directly requires exporting countries to mathematically demonstrate that:
(A) The export is not detrimental to species survival in the wild.
(B) The shark was caught strictly using traditional wooden sailing vessels.
(C) The shark's meat will be distributed free of charge to developing nations.
(D) The entire global population of the species exceeds one billion individuals.

2008
165. Which legal statement regarding UNCLOS EEZ provisions is incorrect?
(A) Foreign vessels permitted to fish in an EEZ must comply with the conservation measures of the coastal state.
(B) The coastal state has sovereign rights for the purpose of exploring and exploiting living resources.
(C) If a coastal state does not have the capacity to harvest the entire allowable catch, it must strictly let the surplus die of old age.
(D) The coastal state has jurisdiction over the establishment and use of artificial islands and installations.

2023
166. What is the best description of the legal relationship between UNCLOS and RFMOs?

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(A) RFMOs are illegal entities strictly forbidden by UNCLOS.
(B) UNCLOS mandates cooperation for high seas conservation, which is practically implemented through the establishment of RFMOs.
(C) RFMOs possess absolute sovereign authority that overrides UNCLOS.
(D) UNCLOS only applies to territorial waters, making RFMOs entirely voluntary.

2018
167. From the obligations set out in UNFSA, one can infer that member states are strictly required to:
(A) Share comprehensive scientific catch data and comply with boarding and inspection procedures.
(B) Completely ignore the precautionary approach in high seas management.
(C) Ensure absolute zero bycatch in all industrial operations.
(D) Eliminate all forms of aquaculture within their borders.

2002
168. A significant operational disadvantage of international treaties like CITES and UNFSA is:
(A) Their effectiveness is heavily hampered by non-signatory states and uneven domestic enforcement.
(B) They inherently cause immediate biological stock collapse.
(C) They mandate the destruction of all artisanal fishing gear.
(D) They promote the Tragedy of the Commons by enforcing open access.

2012
169. Ecosystem-Based Fishery Management (EBFM) is fundamentally defined as an approach that:
(A) Considers the entire ecological system, including human dimensions, rather than managing single species in isolation.
(B) Maximizes the physical harvest of a single apex predator species.
(C) Strictly prevents any human extraction of marine resources.
(D) Focuses exclusively on the economic profitability of the fishing fleet.

2014
170. Consider the following statements regarding the objectives of EBFM:
I. Sustaining entire ecosystem structures and functions.
II. Completely ignoring the socio-economic needs of coastal communities.
III. Accounting for complex food-web interactions in stock assessments.
Which of the above statement(s) is/are correct?
(A) I and III
(B) I and II
(C) II and III
(D) I, II and III

2013
171. A crucial paradigm shift from traditional management to EBFM involves transitioning from:
(A) Holistic environmental monitoring to focusing solely on fleet fuel usage
(B) Target-species only management to evaluating multi-species interactions and habitat integrity
(C) Multi-species assessments to strictly single-species MSY targets
(D) Precautionary approaches to purely reactive management

2010
172. Applying EBFM principles directly causes managers to actively regulate:
(A) The exact market price of seafood products
(B) The specific color of vessel hulls
(C) The incidental bycatch of non-commercial benthic invertebrates
(D) The phase of the moon during fishing operations

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2019
173. Which of the following correctly describes the human element within the EBFM framework?
(A) Humans are considered external, unnatural disruptors that must be entirely removed.
(B) EBFM strictly ignores all economic and social data.
(C) The framework aims to eliminate all traditional ecological knowledge.
(D) Humans are recognized as integral, interactive components of the broader ecosystem.

2009
174. All of the following are foundational principles of Ecosystem-Based Fishery Management EXCEPT:
(A) Applying the precautionary approach
(B) Minimizing gear impacts on essential fish habitats
(C) Incorporating adaptive management to address climate uncertainties

(D) Maximizing the single-species yield regardless of bycatch

2014

175. A fisheries scientist utilizes Ecopath with Ecosim software. This is a direct methodological application meant to:
(A) Design optimal hydraulic winches for trawl nets
(B) Model complex multi-species trophic interactions for EBFM implementation
(C) Precisely navigate the vessel using satellite data
(D) Calculate the chemical biodegradation rate of synthetic lines

2013

176. Which statement regarding the operationalization of EBFM is incorrect?
(A) EBFM requires significantly more extensive ecological data than single-species models.
(B) EBFM incorporates spatial management tools like Marine Protected Areas.
(C) EBFM seeks to balance diverse societal objectives with ecological sustainability.
(D) EBFM completely discards all previous traditional stock assessment parameters.

2024

177. What is the best ecological justification for explicitly managing forage fish populations under EBFM?
(A) Overharvesting starves dependent apex predators and seabirds.
(B) Forage fish are the only species capable of causing ocean acidification.
(C) Forage fish inherently possess the highest market value per kilogram.
(D) Forage fish are completely immune to all forms of bycatch gear.

2016

178. Which of the following correctly outlines a logical sequence of EBFM planning?
(A) Implement punitive fines → Ignore stakeholder input → Assess single species → Define goals
(B) Define ecosystem boundaries → Identify key stakeholders → Assess ecological and socio-economic risks → Develop integrated management plans
(C) Develop management plans → Define ecosystem boundaries → Assess risks → Identify stakeholders
(D) Identify stakeholders → Implement punitive fines → Define boundaries → Ignore risks

2011

179. From the inherent complexity and uncertainty of entire marine ecosystems, one can infer that EBFM must strongly rely on:
(A) Static, unchanging laws enacted a century ago
(B) Rigid, mathematically perfect deterministic predictions
(C) The total elimination of all scientific stock assessments
(D) Iterative, flexible adaptive management frameworks

2017

180. A major practical disadvantage or hurdle in rapidly implementing EBFM in developing coastal nations is:
(A) It inherently violates the FAO Code of Conduct.
(B) It promotes illegal, unregulated fishing.
(C) It strictly requires the immediate banning of all artisanal fishing gears.
(D) The massive requirement for comprehensive multi-disciplinary data and institutional capacity.

2021

181. "Fishing down the marine food web" is scientifically defined as the process where:
(A) Fisheries progressively shift from targeting large apex predators to harvesting smaller, lower-trophic-level species.
(B) Trawl nets are heavily weighted to dig exclusively into the benthic mud.
(C) Fishermen sequentially move from shallow coastal waters to deep abyssal zones.
(D) All lower trophic level species naturally mutate to become top predators.

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2010

182. The standard metric utilized to quantify "fishing down the food web" across a region's historical landings is the:
(A) Maximum Sustainable Yield (MSY)
(B) Catch Per Unit Effort (CPUE)
(C) Intrinsic growth rate (r)
(D) Mean Trophic Level (MTL)

2012

183. The severe depletion of large predatory fish populations often precipitates sudden explosions in the biomass of their prey species. This specific ecological phenomenon is termed:
(A) A trophic cascade

entirely dissipated and the stock collapses.
(C) The government will perfectly subsidize all fleet operational costs forever.
(D) The fishery will naturally stabilize exactly at Maximum Economic Yield.

2025
218. A fisheries management regime where the central government strictly dictates mesh sizes, enforces seasonal closures, and issues limited licenses is termed:
(A) A state-regulated command-and-control regime
(B) A pristine open-access regime
(C) A community-based informal regime
(D) A strict private ownership monopoly

2009
219. In rights-based fisheries management, the acronym TURF specifically stands for:
(A) Territorial Use Rights for Fishing
(B) Total Unregulated Recreational Fishing
(C) Transboundary Unreported Resource Fisheries
(D) Trophic Utilization Rate Frameworks

2019
220. Allowing infinite new vessels to enter a highly profitable open-access fishery will eventually cause:
(A) The absolute maximization of total global biomass
(B) Severe economic rent dissipation, driving fleet profits down to zero
(C) An automatic switch to perfectly selective fishing gears
(D) The immediate reversal of growth overfishing

2001
221. Which of the following is correctly identified as a formal rights-based catch share management system?
(A) Subsidizing marine diesel fuel
(B) Allocating Individual Transferable Quotas (ITQs) to specific fishers
(C) Implementing a complete, permanent ban on all fishing
(D) Encouraging unlimited recreational access to coastal reefs

2006
222. Consider the following specific forms of property rights in fisheries:
I. Open Access (no assigned rights).
II. State Property (government controls access).
III. Communal Property (customary groups manage access).
IV. Private Property (individuals hold exclusive transferrable quotas).
Which of the above are standard recognized categories of property rights in fisheries economics?
(A) I, II, III, and IV
(B) II, III, and IV
(C) I and III only
(D) IV only

2014
223. All of the following are foundational features of successfully functioning TURFs EXCEPT:
(A) Clearly defined spatial boundaries
(B) The ability to exclude unauthorized outsiders
(C) Guaranteed free access to highly migratory international tuna fleets
(D) Strong local governance and internal rule enforcement

2014
224. A manager wishes to incentivize long-term stewardship among individual fishers while ending the dangerous "race for fish." The most appropriate application is:
(A) Implementing an Individual Transferable Quota (ITQ) system
(B) Mandating open-access fishing strictly during hurricanes
(C) Heavily subsidizing the construction of larger factory trawlers
(D) Removing all minimum size limits

2021
225. Which economic statement regarding open-access fisheries is fundamentally incorrect?
(A) The absence of property rights leads to catastrophic overcapitalization.
(B) Marginal revenue equals marginal cost at the point of bioeconomic equilibrium in open access.
(C) Individual fishers have no rational incentive to leave fish in the water for tomorrow.
(D) Open access mathematically guarantees that the fishery operates precisely at Maximum Economic Yield.

2013
226. What is the best logical reason why TURFs are highly successful for managing benthic resources (e.g., abalone, lobsters) but struggle with pelagic resources?
(A) Benthic species are sedentary, while pelagic species migrate outward.

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2009

192. A significant disadvantage or limitation of using catch-based MTL as the sole indicator of ecosystem health is:
(A) It inherently requires the destruction of the fishing gear.
(B) It completely ignores the laws of thermodynamics.
(C) It strictly demands the use of highly destructive poisons.
(D) Catch data is heavily influenced by economic markets and regulations, which may not reflect true ecosystem abundance.

2021

193. In modern fisheries, artificial sea ranching is specifically distinguished from stock enhancement by which characteristic?
(A) Ranching releases juveniles into the wild with the explicit intent of harvesting all of them upon their return or maturation.
(B) Ranching completely relies on natural spawning without hatcheries.
(C) Ranching involves rearing fish to maturity in totally closed onshore tanks.
(D) Ranching focuses exclusively on eradicating invasive species.

2011

194. The strict biological limit to how many hatchery-reared juveniles can be successfully added to an open water environment is fundamentally determined by the ecosystem's:
(A) Distance to the nearest seaport
(B) Carrying capacity
(C) Mean Trophic Level
(D) Exclusive Economic Zone boundary

2003

195. The widespread release of millions of hatchery-reared fry into an already populated natural water body directly introduces a high risk of:
(A) Decreasing the total primary productivity of the entire lake
(B) Severe density-dependent competition with wild conspecifics for limited food
(C) Immediate elimination of all native marine mammals
(D) Instantly reversing the effects of ocean acidification

2014

196. The continuous interbreeding between highly inbred hatchery fish and wild populations will genetically cause:
(A) Outbreeding depression and a severe reduction in the genetic fitness of the wild stock
(B) Massive increases in wild hybrid vigor
(C) The rapid evolution of entirely new endemic species
(D) The complete cessation of all natural mortality

NODIA

2007

197. Which practice correctly identifies a method to improve the post-release survival of enhanced stocks?
(A) Releasing larvae exclusively during massive toxic algal blooms
(B) Exposing juveniles to simulated predators and natural prey before release (behavioral conditioning)
(C) Rearing fish in completely sterile, featureless tanks until release
(D) Releasing exclusively triploid hybrids into highly polluted estuaries

2008

198. All of the following are potential ecological risks associated with artificial stock enhancement EXCEPT:
(A) Transmission of novel pathogens from hatcheries to wild stocks
(B) Alteration or loss of natural genetic population structure
(C) Displacement of wild juveniles from preferred nursery habitats
(D) Guaranteed permanent restoration of the virgin ecosystem structure

2011

199. A manager observes that releasing twice as many salmon smolts yields smaller returning adults but the same total biomass. This is a practical demonstration of:
(A) Ghost fishing dynamics
(B) Density-dependent growth limitation in the marine phase
(C) The Tragedy of the Commons
(D) Perfect eumetric fishing

2016

200. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Hatchery operations for stock enhancement often utilize a very small number of broodstock.
Reason (R): Using a small number of broodstock directly causes a genetic bottleneck, severely

reducing the diversity of the released fry.
In the light of the above statements, choose the most appropriate answer from the options given below:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019
201. Which underlying assumption regarding stock enhancement is fundamentally incorrect?
(A) Natural recruitment is strictly limited by the availability of spawning habitat or survival of early life stages.
(B) The natural environment has an infinite carrying capacity for target species.
(C) Hatchery-reared fish often exhibit lower predator-avoidance skills than wild fish.
(D) Comprehensive monitoring is required to assess the true return rate of enhanced fish.

2008
202. What is the best scientific method for unequivocally determining the success and economic viability of a sea ranching program?
(A) Assuming every single released fry reaches marketable adult size
(B) Utilizing mass marking techniques (e.g., coded wire tags, thermal otolith marks) to strictly quantify the proportion of hatchery fish in the final harvest
(C) Solely monitoring the total annual profit of the commercial fleet
(D) Measuring the ambient sea surface temperature

2025
203. If a mass release of tiger prawn post-larvae yields a return rate of 0.5% in the commercial catch, one can infer that:
(A) The local ecosystem has a massive abundance of vacant niches.
(B) The economic viability of the enhancement program is highly dependent on the cost of rearing versus the market value of the harvested adults.
(C) The wild tiger prawn population has been entirely exterminated.
(D) Maximum Sustainable Yield has been mathematically achieved.

2022
204. A major biological disadvantage of relying on heavy continual stocking to maintain a fishery is:
(A) It perfectly mimics natural evolutionary processes.
(B) It completely permanently eradicates all forms of IUU fishing.
(C) It masks the underlying causes of wild stock decline, such as severe habitat degradation or overfishing.
(D) It strictly dictates the use of square mesh codends.

2024
205. Floodplain wetlands (locally known as beels or maans in India) are primarily characterized ecologically as:
(A) Highly productive ecotones functioning as crucial nursery and feeding grounds
(B) Extremely deep, strictly oligotrophic marine trenches
(C) Fast-flowing, cold-water lotic systems
(D) Permanently hyper-saline inland basins

2004
206. In basic fisheries limnology, a strictly flowing water ecosystem is termed lotic, whereas a standing water ecosystem (like a lake) is termed:
(A) Estuarine
(B) Benthic
(C) Pelagic
(D) Lentic

2016
207. A fundamental ecological characteristic governing reservoir fisheries productivity is:
(A) The complete absence of any phytoplankton
(B) The continuous, unidirectional flow of massive saltwater currents
(C) The initial trophic upsurge following inundation, which gradually declines as flooded nutrients are exhausted
(D) The absolute stability of water levels year-round

2015
208. Severe seasonal drawdown (water level reduction) in hydroelectric reservoirs directly causes:
(A) The immediate eradication of all aquatic weeds
(B) Massive enhancement of deep-water spawning sites
(C) Exposure and desiccation of shallow littoral spawning grounds and benthic fauna
(D) A permanent transition into a highly lotic ecosystem

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2016

209. Which concept correctly identifies the primary driver of high fish productivity in natural river-floodplain systems?
(A) The Flood Pulse Concept
(B) The Maximum Extraction Paradigm
(C) The Ghost Fishing Cycle
(D) The Mean Trophic Cascade

2004

210. Match the hydrological water body type in List I with its defining fisheries characteristic in List II.
List I: (Water Body Type)
P. Riverine
Q. Reservoir
R. Floodplain Wetland
S. Estuarine
List II: (Fisheries Characteristic)
1. Subject to extreme tidal salinity fluctuations
2. Driven by longitudinal connectivity and lotic flows
3. Characterized by severe seasonal artificial drawdowns
4. Relies heavily on lateral connectivity and seasonal pulsing
(A) P-4, Q-3, R-1, S-2
(B) P-2, Q-3, R-4, S-1
(C) P-1, Q-2, R-3, S-4
(D) P-3, Q-1, R-4, S-2

2001

211. All of the following are classic ecological features defining healthy estuarine fisheries EXCEPT:
(A) High nutrient trapping causing immense primary productivity
(B) Functioning as critical nursery grounds for euryhaline marine species
(C) Dominated by steep salinity gradients and tidal flushing
(D) Severe isolation from all freshwater riverine inputs

2018

212. A manager intentionally clears excessive submerged macrophytes from a choked oxbow lake. This application aims to:
(A) Completely stop the natural flood pulse
(B) Enhance phytoplankton production and create navigable space for fishing gear
(C) Eradicate all native benthic macroinvertebrates
(D) Increase the lake's salinity to oceanic levels

2018

213. Which statement regarding reservoir fisheries is fundamentally incorrect?
(A) Deep, steep-sided reservoirs are generally far less productive than shallow, sprawling ones.
(B) Stocking is frequently required to utilize new pelagic niches created by the dam.
(C) Anadromous migrations are completely blocked without dedicated passage facilities.
(D) Fish productivity in reservoirs is uniform and static across all decades of its existence.

2010

214. What is the best biological classification for organic energy inputs that originate from terrestrial riparian vegetation falling into a river?
(A) Autochthonous production
(B) Allochthonous production
(C) Primary calcification
(D) Pelagic upwelling

2010

215. From the observation that an oxbow lake has transitioned into a dense swamp entirely dominated by emergent macrophytes, one can infer that:
(A) The lake is undergoing rapid natural eutrophication and terrestrialization.
(B) The lake's fishery will instantly shift to massive pelagic tunas.
(C) The Mean Trophic Level has mathematically maximized.
(D) The water has become completely oligotrophic.

2022

216. A primary disadvantage of relying entirely on heavy stocking of Indian Major Carps (IMCs) in large reservoirs is:
(A) The guaranteed prevention of any IUU fishing
(B) The immediate elimination of all local recreational activities
(C) The rapid onset of ocean acidification
(D) The massive economic cost of rearing fingerlings, which may suffer intense predation by resident carnivores

NODIA

2016

217. In natural resource economics, the "Tragedy of the Commons" in a completely open-access fishery strictly dictates that:
(A) All fishers will spontaneously restrict their catch to ensure Maximum Sustainable Yield.
(B) Rational individual actors will exploit the shared resource until economic rent is

(B) Biotic homogenization
(C) Eumetric fishing
(D) The open access tragedy

2010

184. The complete functional removal of top marine predators will directly cause:
(A) Immediate restoration of strict ecosystem stability
(B) Rapid enhancement of coral reef calcification rates
(C) The elimination of all dissolved oceanic carbon dioxide
(D) Profound restructuring of the lower trophic web, often destabilizing the ecosystem

2009

185. Which statement correctly reflects Daniel Pauly's original hypothesis regarding the marine food web?
(A) Harvesting low trophic level species maximizes the genetic diversity.
(B) Continued MTL reduction results in fisheries dominated by plankton.
(C) Fisheries only ever target small pelagic fish, ignoring large predators.
(D) The Mean Trophic Level strictly increases as a fishery matures.

2024

186. All of the following are considered classic indicators of fishing down the food web EXCEPT:
(A) A long-term decline in the Mean Trophic Level of total catch
(B) Serial depletion of large, long-lived piscivorous species
(C) A sustained, historical increase in the proportion of caught apex predators
(D) A transition of fleet gear from large-mesh longlines to fine-mesh trawls targeting shrimp

2013

187. A researcher assigns a trophic level of 4.5 to tuna and 2.2 to sardines, then calculates the weighted average based on annual landings. This is a direct application of calculating:
(A) Mean Trophic Level of the catch
(B) Bycatch survival rates
(C) Total Allowable Effort
(D) Ecosystem carrying capacity

2010

188. Which statement regarding modern critiques of the "fishing down" hypothesis is incorrect?
(A) Some fisheries exhibit "fishing through" the food web by adding low trophic catch without abandoning top predators.
(B) Spatial expansion of fleets can temporarily mask declines in local Mean Trophic Level.
(C) Changes in market demand and fuel prices can independently drive shifts in the targeted trophic level.
(D) MTL calculations from landings always perfectly mirror the actual abundance in the ecosystem.

2018

189. What is the best biological reason why ecosystems heavily depleted of top predators become highly vulnerable?
(A) They lose functional redundancy, making them highly susceptible to environmental shocks and climate change.
(B) Lower trophic levels reproduce far too slowly to sustain a fishery.
(C) They entirely lose their capacity to conduct photosynthesis.
(D) The water becomes overly saturated with dissolved oxygen.

2009

190. Consider the following observed changes in a marine ecosystem:
I. Collapse of top predator populations.
II. Significant increase in mid-trophic level biomass.
III. Long-term decline in the Mean Trophic Level of total landings.
IV. Full recovery of the original virgin biomass structure.
Which of the above are standard indicators of "fishing down the food web"?
(A) I and II
(B) I, II, and III
(C) IV only
(D) III only

2024

191. From the observation of a massive spike in small elasmobranch (rays and small sharks) populations following the overfishing of large pelagic sharks, one can accurately infer:
(A) The immediate occurrence of ocean acidification
(B) The complete failure of the biological pump
(C) The exact Maximum Economic Yield
(D) A classic example of mesopredator release

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(B) Pelagic species are fundamentally immune to all forms of fishing gear.
(C) Benthic resources possess absolutely zero commercial market value.
(D) TURFs strictly prohibit the use of all motorized vessels.

2018

227. From the implementation of a strict ITQ system, one can legally infer that the participating fishers possess:
(A) Exclusive, quasi-property harvest rights to a specific proportion of the Total Allowable Catch.
(B) Absolute sovereign ownership of the ocean water itself.
(C) The legal right to use highly destructive poisons.
(D) Exemption from all international maritime safety laws.

2025

228. A widely criticized social disadvantage of rapid ITQ privatization in previously open fisheries is:
(A) It leads to quota consolidation, marginalizing small-scale fishers.
(B) It drastically increases the total volume of marine microplastics.
(C) It eliminates all need for scientific biological stock assessment.
(D) It inherently forces fishers to use exclusively unmotorized canoes.

2013

229. Community-Based Fisheries Management (CBFM) fundamentally empowers:
(A) Multinational corporate entities to dictate local quota limits
(B) Distant-water high seas fleets to harvest strictly within coastal EEZs
(C) Completely unregulated open-access harvesting
(D) Local resource users to possess primary responsibility and authority over the management of local fisheries

2005

230. Arrange the following levels of stakeholder participation in co-management from lowest (least local power) to highest (most local power):
I. Government consultation with community
II. Complete community control and delegation
III. Purely top-down government instruction/ information
IV. Joint cooperative management boards
Which option shows the correct arrangement?
(A) III, I, IV, II
(B) I, III, II, IV
(C) III, IV, I, II
(D) IV, I, III, II

2001

231. Co-management is technically defined as a formal power-sharing and responsibility-sharing arrangement between:
(A) State/government authorities and local communities/resource users
(B) Two competing international factory trawler companies
(C) Strictly different scientific research institutes
(D) Terrestrial farmers and oceanic aquaculturists

2002

232. Decentralization of management authority to local coastal villages often causes which direct operational effect?
(A) A massive expansion of the fleet's carbon footprint
(B) The immediate dissolution of all international UNCLOS treaties
(C) Increased local compliance and reduced enforcement costs due to peer pressure
(D) The absolute eradication of all highly migratory species

2017

233. Which correctly identifies a primary asset utilized heavily in successful CBFM systems?
(A) Traditional/Local Ecological Knowledge (LEK) regarding spawning sites and seasons
(B) Massive, unrestricted government fuel subsidies
(C) Heavy militarized naval bombardments
(D) Complete dependence on distant satellite-based automated fishing

2024

234. All of the following are characteristic features of functional Community-Based Fisheries Management EXCEPT:
(A) Participatory decision-making processes
(B) Incorporation of customary laws and taboos
(C) High levels of local social cohesion
(D) Strict, unilateral top-down quota imposition by distant central bureaucrats

2003

235. A government establishes a joint committee of local fisher chiefs and state scientists to resolve gear conflicts in a bay. This is a direct application of:

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ocean currents. This is a direct application of designing:
(A) An ecologically connected MPA network promoting larval dispersal
(B) A destructive ghost fishing matrix
(C) A highly lethal trophic cascade
(D) A strictly terrestrial logging reserve

2010
272. Which biological statement regarding the strict utility of permanent MPAs is incorrect?
(A) MPAs typically allow severely depleted sedentary benthic species to drastically recover.
(B) MPAs protect highly complex critical habitats from destructive bottom-towed fishing gears.
(C) MPAs are universally the single most effective tool for managing highly migratory oceanic tunas.
(D) MPAs often provide critical undisturbed baselines for scientific comparative research.

2004
273. What is considered the most significant regional fisheries benefit generated by a highly successful, mature no-take zone?
(A) It exports larvae to replenish fished stocks in surrounding areas.
(B) It inherently eliminates the need to pay for vessel fuel.
(C) It causes the complete extinction of all apex predators.
(D) It entirely prevents the occurrence of extreme climatic weather events.

2016
274. Upon observing a government forcefully close 30% of its coastal waters to all fishing without reducing the fleet, a manager can instantly infer that:
(A) Massive effort displacement will heavily concentrate the entire fleet into the remaining 70%, potentially causing localized overfishing.
(B) All vessels will spontaneously completely cease operations and exit the industry.
(C) The global Mean Trophic Level will instantly maximize perfectly.
(D) Maximum Sustainable Yield dictates absolute open access everywhere.

2019
275. A primary operational disadvantage heavily crippling the effectiveness of spatial MPAs in many developing nations is:
(A) The absolute biological impossibility of fish spawning without human assistance
(B) Deficiencies in funding, surveillance, and enforcement against poaching.
(C) They inherently cause immediate and severe ocean warming anomalies.
(D) They legally require the total destruction of all mangrove forests.

2009
276. Identify the strictly correct pair contrasting a spatial control with a temporal control.
(A) Spatial: Establishing a fixed no-take coral reef reserve | Temporal: Implementing a strict two-month monsoon fishing ban
(B) Spatial: Minimum mesh size limits | Temporal: Strictly limiting vessel engine power
(C) Spatial: Setting total allowable weight catch | Temporal: Banning all bottom trawling globally
(D) Spatial: Subsidizing commercial diesel fuel | Temporal: Utilizing square-mesh codends

2022
277. In classical fisheries science, "eumetric fishing" is precisely defined as a strategic management regime where:
(A) Fishing effort and gear selectivity (age/size at first capture) are perfectly optimized together to mathematically maximize the yield per recruit.
(B) The maximum physical volume of completely unregulated bycatch is achieved.
(C) Absolute open-access is brutally enforced across the entire ocean.
(D) Only heavily localized artisanal hand-gathering is strictly permitted.

2005
278. The standard mathematical curve representing the strict probability of a fish being retained by a specific gear as a function of its physical length is termed the:
(A) Yield-per-recruit asymptote
(B) Selectivity ogive
(C) Maximum Economic Yield trajectory
(D) Trophic cascade hyperbola

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This economic behavioral effect is correctly termed:
(A) Growth overfishing
(B) Capital stuffing (effort creep)
(C) Biotic homogenization
(D) Ghost fishing

2013

245. Which regulatory action correctly exemplifies a pure effort-based input control?
(A) Setting a strict Total Allowable Catch of 10,000 metric tons
(B) Mandating that all caught billfish must be legally released alive
(C) Restricting vessels to fishing only 15 days per calendar month
(D) Requiring eco-labeling certification on all exported fillets

2016

246. All of the following are classified fundamentally as input controls EXCEPT:
(A) Restricting total engine horsepower limits
(B) Mandating a maximum number of crab traps per vessel
(C) Freezing the total issuance of commercial fishing licenses
(D) Establishing Individual Transferable Quotas (ITQs)

2010

247. A manager legally restricts maximum engine power to 100 HP per vessel. This is an application directly attempting to control:
(A) The physical towing speed and gross sweeping area of trawl nets
(B) The exact gender ratio of the caught fish
(C) The exact phase of the moon when fishing occurs
(D) The absolute severity of oceanic deoxygenation

2003

248. Which statement regarding strict input controls is completely incorrect?
(A) Input controls directly guarantee a precise, biologically exact total catch weight.
(B) Input controls are often far easier to enforce visibly than complex output quotas.
(C) Fishers frequently circumvent input controls by heavily optimizing unregulated inputs.
(D) A license freeze alone cannot stop the total fishing power of a fleet from expanding.

2025

249. What is the most appropriate definition of "effort creep" in a restricted input fishery?
(A) The gradual reduction of all fishing activities due to sheer economic bankruptcy
(B) The insidious increase in true fishing power due to technological advances (e.g., better sonar), despite nominal controls
(C) The slow physical decay of abandoned fishing nets on coral reefs
(D) The deliberate physical movement of fish away from designated MPAs

2015

250. From the widespread phenomena of capital stuffing, an economist can logically infer that fishers strongly tend to:
(A) Perfectly align their activities with Maximum Sustainable Yield targets.
(B) Voluntarily surrender all their equipment to the central government.
(C) Substitute unregulated technical inputs for regulated inputs to maintain rates.
(D) Abandon motorized fishing completely in favor of hand collection.

2005

251. A significant advantage of utilizing basic input controls (like limited entry) in data-poor developing fisheries is:
(A) They completely eliminate all forms of aquatic bycatch.
(B) They mandate the highly complex real-time weighing of all catches at sea.
(C) They are relatively straightforward to visually monitor and structurally enforce at port.
(D) They inherently reverse the process of global ocean acidification.

2008

252. Identify the correct pair matching the specific input control with its primary targeted regulatory mechanism.
(A) ITQ Allocation - Restricting vessel hull length
(B) License Limitation - Capping the maximum total number of participating operators
(C) Minimum Legal Size - Capping the total engine horsepower
(D) Bycatch Quota - Regulating the number of hooks per longline

2018

253. In fisheries management, the output control acronym TAC strictly stands for:

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ANSWERS

1. (A) Ecological sustainability
Ecological sustainability serves as the foundational principle ensuring that fishing activities do not compromise the long-term health, structural integrity, or functional processes of marine ecosystems. This framework prioritizes resource conservation and habitat preservation over short-term economic gains, maintaining biological diversity and trophic relationships so that marine environments remain resilient and productive for future generations.

2. (C) Exploitation levels are balanced with ecosystem carrying capacity.
Sustainable fisheries management requires balancing exploitation levels directly with the natural carrying capacity of the ecosystem. This approach ensures that the harvest of target species does not exceed the environment's ability to replenish itself. It maintains the stability of the food web and prevents stock depletion, securing long-term biological viability and ecological integrity.

3. (A) Information is uncertain or inadequate.
The precautionary approach is systematically applied when scientific information is uncertain, unreliable, or inadequate. Under this principles-based framework, the absence of robust scientific data should not justify postponing management actions to prevent serious environmental degradation. It mandates cautious catch limits and adaptive strategies to protect stocks from potential irreversible collapse.

4. (D) Trophic cascades within the marine food web.
Removing apex predators from a marine ecosystem disrupts top-down regulatory mechanisms, which typically triggers a trophic cascade throughout the food web. This functional loss leads to an unnatural increase in mesopredator populations, which subsequently overconsume lower-trophic-level prey. Such imbalances alter community composition, reduce biodiversity, and destabilize the entire aquatic habitat.

5. (B) Spawning stock biomass
Spawning stock biomass represents the total weight of all sexually mature fish within a population that are capable of reproducing. This biological parameter serves as a critical indicator for determining stock viability and recruitment potential. Monitoring this metric helps managers prevent recruitment overfishing by ensuring a sufficient reproductive base exists to sustain the fishery.

6. (C) Maximizing fishing fleet overcapacity
Maximizing fishing fleet overcapacity directly contradicts the fundamental principles of sustainable fisheries management because it leads to severe overexploitation and economic rent dissipation. Sustainable practices focus on maintaining fishing mortality at levels compatible with resource replenishment. This involves implementing science-based catch limits, reducing bycatch, and protecting essential habitats rather than promoting excessive fleet expansion.

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7. (D) Adaptive management principles
Adaptive management principles involve adjusting harvest quotas and regulatory measures in real time as environmental conditions and stock recruitment patterns change. This dynamic approach allows managers to respond proactively to unexpected climate anomalies, ensuring that exploitation levels match current biological realities. It treats management actions as experiments to improve knowledge and long-term sustainability.

8. (A) Fisheries strictly impact only the targeted species in isolation.
Fisheries do not impact targeted species in isolation because marine ecosystems are highly interconnected systems. Harvesting activities inevitably influence non-target species, alter interspecific competition, and disrupt trophic relationships within the food web. Maintaining habitat integrity is essential for successful stock replenishment, meaning management must consider broader ecological interactions to be truly effective.

and immediately.
(B) Be completely abandoned by all commercial fishers instantly.
(C) Consolidate into the hands of a few large corporate operators.
(D) Guarantee absolutely infinite virgin biological biomass

2006
263. A critical social disadvantage and frequent philosophical criticism of implementing strict ITQ systems is:
(A) It forces fleets to operate exclusively during terrifying hurricanes.
(B) It favors efficiency and privatization over historic community equity.
(C) It directly causes immediate and severe recruitment overfishing.
(D) It fundamentally prohibits the calculation of Maximum Sustainable Yield.

2005
264. Identify the correct pair that properly contrasts an output control with an input control.
(A) Output control: Individual Transferable Quota | Input control: Freezing the total number of issued licenses
(B) Output control: Restricting total engine power | Input control: Setting a hard ton quota
(C) Output control: Mandating Turtle Excluder Devices | Input control: High-grading of catch
(D) Output control: Mesh size restrictions | Input control: Spatial Marine Protected Areas

2012
265. In spatial management, "no-take zones" are rigorously defined as specific geographic areas where:
(A) All forms of extractive fishing activities are strictly prohibited.
(B) Only completely unregulated international factory ships are allowed.
(C) Fishers can take absolutely infinite volumes of catch without limits.
(D) Only highly toxic chemical fishing methods are legally permitted.

2010
266. A strictly enforced "closed season" is a fundamental temporal management control primarily designed to:
(A) Force fishers to violently protest.
(B) Protect highly vulnerable biological life stages, such as dense spawning aggregations or peak recruitment periods.
(C) Drastically maximize the total operational carbon footprint of the fleet.
(D) Ensure the local market is continuously flooded with fresh seafood year-round.

2025
267. A well-designed Marine Protected Area (MPA) increases biomass within its borders. The biological emigration of adult fish across the boundary into adjacent fished areas is ecologically termed:
(A) The Spillover Effect
(B) The Tragedy of the Commons
(C) Eumetric Fishing
(D) Bycatch Discarding

2013
268. Rapidly establishing a comprehensive no-take MPA strictly over a known grouper spawning site will directly cause:
(A) High protection of mature broodstock from targeted fishing mortality during reproduction
(B) Immediate eradication of all marine microplastics in the ocean
(C) Complete cessation of the local oceanic nitrogen cycle
(D) Massive acceleration of global ocean acidification

2004
269. Which technical control legally mandates that all caught individuals below a precisely defined length must be safely returned to the water?
(A) Minimum Legal Size (MLS)
(B) Total Allowable Catch (TAC)
(C) Maximum Economic Yield (MEY)
(D) Turtle Excluder Device (TED)

2006
270. All of the following are universally recognized strictly as spatial or temporal controls EXCEPT:
(A) Real-time rotating closures based on bycatch trigger limits
(B) Strictly enforced permanent no-take marine reserves
(C) Seasonal fishing bans during monsoon/spawning periods
(D) Mandatory implementation of pure Individual Transferable Quotas (ITQs)

2006
271. A spatial planner rigorously spaces multiple smaller MPAs along a coastline connected by

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2021

287. A major functional disadvantage of strictly utilizing square mesh rather than diamond mesh in trawl codends is:
(A) It allows excessively too many massive adult mega-spawners to escape.
(B) It severely increases the immediate onset of lethal ocean acidification.
(C) It suffers from lower physical endurance and higher manufacturing costs.
(D) It inherently prevents water flow, acting strictly as a solid parachute.

2022

288. Identify the strictly correct pair linking a specific fishing gear with its fundamental primary selection mechanism.
(A) Gillnet - Strict physical girth limitation determining enmeshing and wedging
(B) Longline - Strict visual selection based solely on fish color
(C) Bottom Trawl - Highly strict individual intelligence assessment
(D) Purse Seine - Precise individual mouth-gape limitation

2010

289. In severe fisheries socioeconomic dynamics, "inter-sectoral conflict" is strictly defined as disputes occurring between:
(A) Completely identical artisanal vessels using identical gears in the exact same village
(B) Competing entities from entirely different sectors, such as highly industrialized fleets clashing heavily with small-scale artisanal fishers
(C) Two strictly landlocked countries heavily arguing over distant deep-sea mining rights
(D) A single solitary fisher and local oceanic apex predators

2016

290. "Intra-sectoral conflict" is most accurately represented by heated, violent disputes strictly arising between:
(A) Terrestrial upland farmers and massive offshore tuna longliners
(B) Competing groups of highly similar small-scale fishers fighting heavily over access to the exact same localized reef
(C) Unrelated coastal tourism operators and central government tax auditors
(D) Oceanic cargo freighters and purely recreational jet-ski operators

2011

291. To heavily mitigate severe physical gear conflicts between motorized trawlers and static traditional gears, governments frequently implement strict:
(A) Zonation mapping, legally restricting highly destructive trawlers completely outside designated nearshore depth contours
(B) Absolute elimination of all oceanic salinity gradients
(C) Unrestricted open-access subsidies for absolutely all citizens
(D) Total privatization of strictly all high-seas international waters

2025

292. Unregulated nearshore incursions by massive industrial bottom trawlers frequently cause which extreme socioeconomic effect on local coastal communities?
(A) Extreme rapid enhancement of strictly artisanal daily catch rates
(B) Unprecedented maximization of traditional local ecological knowledge
(C) Severe immediate destruction of deployed artisanal gears and highly depressed local landings, sparking violent protests
(D) Complete permanent stabilization of the entire global climate system

2010

293. Which socioeconomic intervention correctly seeks to permanently reduce massive fishing effort by fundamentally addressing fisher poverty?
(A) Facilitating and heavily financing viable alternative livelihood options outside the capture fishery
(B) Providing extremely high unrestricted government subsidies purely for marine diesel fuel
(C) Distributing purely free, highly destructive small-mesh nets to every local household
(D) Legally banning absolutely all forms of community cooperation

2019

294. All of the following are generally considered highly viable, sustainable alternative livelihood transitions for strictly marginalized fishers EXCEPT:
(A) Transitioning to managed coastal mariculture and seaweed farming
(B) Transitioning to heavily unregulated, destructive coastal sand mining
(C) Transitioning to guided eco-tourism and strictly catch-and-release recreational

2007

279. Strict optimization of trawl codend mesh sizes is fundamentally implemented primarily to ensure that:

(A) All target fish strictly experience maximum physical injury upon capture.

(B) The physical weight of the net is drastically increased to save fuel.

(C) All large, highly fecund mega-spawners are instantly captured.

(D) Undersized, sexually immature juvenile fish can completely escape and survive to spawn at least once.

2011

280. A regulatory agency mandates an increase in mesh size, effectively shifting the length at 50% retention ($L_{\{50\}}$) heavily to the right. This directly causes:

(A) Initial drop in catch, followed by long-term increase in yield.

(B) An immediate absolute collapse in the survival of all juveniles.

(C) An instantaneous cessation of all global natural mortality.

(D) The rapid acceleration of extreme biotic homogenization.

2015

281. Which technical action is correctly identified as an active gear modification strictly designed to alter species selectivity?

(A) Installing rigid separator grids or strategically placed acoustic pingers on nets

(B) Transitioning the fleet's entire economic structure to ITQs

(C) Mandating strict 12-mile territorial water boundaries

(D) Issuing heavy government fuel subsidies

2002

282. All of the following gear types are widely recognized as being highly selective for species and size EXCEPT:

(A) Specialized hook-and-line

(B) Finely tuned, precisely spaced gillnets

(C) Massive, small-meshed indiscriminate bottom trawls

(D) Traditional unbaited fish traps with designated escape gaps

2022

283. A manager requires all pot fishers to install biodegradable escape panels held strictly by natural twine. This is an application directly aiming to:

(A) Eliminate the complex threat of ghost fishing if the pot is irrevocably lost

(B) Increase the fundamental carrying capacity of the target species

(C) Maximally increase the daily catch rates of the active pot

(D) Radically alter the natural food web through trophic cascades

2004

284. Which biological statement regarding gear selectivity and eumetric fishing is entirely incorrect?

(A) Gear selectivity is heavily influenced by fish morphology, such as strict maximum girth.

(B) Eumetric curves actively demonstrate the critical interaction between fishing mortality (F) and the age of first capture (t_c).

(C) Highly unselective gears frequently precipitate severe growth overfishing.

(D) Implementing smaller, extremely fine mesh sizes mathematically guarantees the highest possible long-term sustainable yield.

2022

285. What is the single best biological objective achieved by meticulously enforcing perfectly eumetric fishing conditions?

(A) Maximization of yield per recruit by strictly preventing the harvest of sub-optimal juveniles

(B) Absolute maximization of all physical bycatch volume

(C) Immediate creation of completely open-access regimes

(D) Total disruption of all natural oceanic carbon cycles

2018

286. From observing a gear selectivity ogive that is extremely steep and sharp, one can mathematically infer that:

(A) The gear strictly catches absolutely every size of fish equally.

(B) The gear is completely totally unselective and highly destructive.

(C) The fish are entirely biologically immune to being caught.

(D) The gear possesses highly precise size selection, sharply differentiating between slightly undersized and strictly legal fish.

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(A) Total allowable catch allocation
(B) Ocean acidification mitigation
(C) Eumetric fishing
(D) Co-management

2023

236. Which statement regarding co-management frameworks is completely incorrect?
(A) Co-management requires significant time and investment to build trust between parties.
(B) The government completely withdraws from all roles, leaving the community isolated without any legal backing.
(C) Co-management blends scientific data with local fisher knowledge.
(D) Successful co-management often requires clearly defined legal rights for the community.

2019

237. What is the single most critical factor for the long-term institutional success of a CBFM initiative?
(A) Unwavering legal recognition and supportive state legislation.
(B) The complete elimination of all commercial trade outside the village.
(C) Mandatory transition to fully industrialized factory vessels.
(D) Absolute exclusion of all scientific data gathering

2004

238. From observing a community that actively patrols its own TURF and socially shames poachers, one can logically infer that:
(A) The Tragedy of the Commons has been completely and totally maximized.
(B) Local stewardship and perceived legitimacy improve regulatory compliance.
(C) The local fish are biologically evolving to swim significantly faster.
(D) The central government must immediately deploy an aircraft carrier to the TURF.

2016

239. A recognized disadvantage of establishing a complex co-management system is the initially high:
(A) Transaction costs regarding time, meetings, and negotiation.
(B) Biological mortality of all discarded or incidental bycatch.
(C) Probability of initiating a massive and lethal trophic cascade.
(D) Requirement to utilize destructive fishing poisons

2021

240. Identify the correct pair representing a management style and its dominant operational trait.
(A) Command-and-Control - Decentralized local rule-making
(B) Open Access - Highly restrictive seasonal closures
(C) Co-management - Shared institutional authority and negotiation
(D) Pure CBFM - Strict enforcement entirely by national military police

2016

241. In fisheries regulation, input controls are strictly defined as management measures that directly restrict:
(A) The amount, intensity, and type of fishing effort deployed
(B) The total physical weight of fish legally landed at the dock
(C) The maximum wholesale price of exported seafood
(D) The quantity of heavy metals naturally occurring in the ocean

2006

242. A "Limited Entry" scheme is a fundamental input control strictly designed to:
(A) Prevent any limits on the size of fish caught
(B) Restrict the total number of vessels or fishers legally participating in a fishery
(C) Guarantee that every single vessel catches the exact same volume of fish
(D) Limit the spatial depth a vessel can safely navigate

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2004

243. When regulating total vessel capacity, standard structural parameters strictly restricted by authorities typically include:
(A) Vessel hull length, gross tonnage, and engine horsepower
(B) The specific dietary preferences of the crew
(C) The overall depth of the oceanic abyss
(D) The chemical composition of the marine sediment

2024

244. Heavily restricting the total number of fishing days allowed per year frequently causes fishers to rapidly invest in massive technological upgrades.

angling
(D) Transitioning into post-harvest value addition and specialized seafood processing

2012
295. A completely depleted coastal community successfully pivots to guiding tourists through recovered coral reefs. This is a direct application of leveraging:
(A) Non-extractive alternative livelihoods (ecotourism) to offset extreme fishing pressure
(B) The absolute Tragedy of the Commons
(C) Pure command-and-control highly militarized enforcement
(D) Severe unrestrained biotic homogenization

2016
296. Which socioeconomic assumption regarding strict alternative livelihood implementation is entirely incorrect?
(A) Successfully transitioning heavily entrenched fishers completely out of the industry requires massive capital and significant re-skilling.
(B) Strong cultural identity and profound attachment strictly to fishing often causes deep resistance to terrestrial jobs.
(C) Simply providing generic secondary incomes automatically perfectly reduces strictly all primary fishing effort unconditionally.
(D) Market access and complex supply chain logistics heavily determine the success of completely new mariculture ventures.

2018
297. What is universally considered the single best foundational mechanism for actively resolving severe, entrenched inter-sectoral fisheries conflicts locally?
(A) Participatory co-management platforms fostering dialogue and compromise.
(B) Total absolute reliance on unilateral highly armed military deployments.
(C) Complete government ignorance hoping the conflict purely resolves itself.
(D) Immediate privatization entirely favoring strictly the wealthiest industrialized corporations

2011
298. From implementing a strict unfunded 60-day seasonal closure on heavily impoverished coastal fleets, one can accurately mathematically infer that without severe mitigation:
(A) Local economic hardship, debt, and subsequent poaching will skyrocket.
(B) Absolute maximum economic yield will perfectly manifest completely instantly.
(C) The fleets will seamlessly transition into high-tech software engineering.
(D) All global oceanic transboundary issues will perfectly legally resolve themselves.

2021
299. A primary recognized advantage of heavily promoting integrated coastal mariculture as an alternative to capture fisheries is:
(A) It can strategically leverage existing maritime skills and provide desperately needed stable supplementary income.
(B) It strictly mathematically necessitates the complete destruction of all coastal mangrove ecosystems.
(C) It requires absolutely zero complex biological knowledge or initial financial capital.
(D) It actively accelerates extremely severe regional growth overfishing.

2005
300. Identify the perfectly correct pair linking a highly specific fisheries conflict with its standard practical spatial mitigation strategy.
(A) Conflict: Intense illegal high seas fishing | Mitigation: Banning entirely all local coastal subsistence angling
(B) Conflict: Massive severe ocean acidification | Mitigation: Simply moving completely all vessels deeper
(C) Conflict: Trawlers destroying local artisanal crab traps | Mitigation: Strictly designating exclusive shallow-water non-trawling zones
(D) Conflict: Extreme overcapitalization of fleet engines | Mitigation: Building extremely massive coastal dams

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(A) Total Allowable Catch
(B) Technical Assessment Criteria
(C) Trophic Abundance Capacity
(D) Territorial Access Control

2002

254. Individual Transferable Quotas (ITQs) explicitly transform a shared, open-access public resource into:
(A) Completely unrestricted global property
(B) Privately held, market-tradable rights to a defined proportion of the harvest
(C) Exclusively state-owned unharvestable assets
(D) Strictly theoretical models with no practical application

2013

255. A central biological requirement for accurately setting a sustainable Total Allowable Catch (TAC) annually is:
(A) Measuring the total length of all coastal beaches
(B) Knowing the exact market price of vessel diesel fuel
(C) Completely eradicating all top apex marine predators
(D) Conducting rigorous, up-to-date scientific stock assessments to estimate current biomass

2016

256. A fleet operating under strict ITQ weight limits frequently discards perfectly marketable, lower-value fish to save quota for higher-value fish. This destructive economic practice is directly termed:
(A) Biotic homogenization
(B) High-grading
(C) Ghost fishing
(D) Effort creep

2002

257. Which characteristic correctly defines the primary advantage of the "transferability" aspect in an ITQ system?
(A) It strictly prevents all vessels from leaving the port.
(B) It legally mandates the transfer of live fish between different oceans.
(C) It promotes economic efficiency by allowing less efficient operators to sell quota and exit the fishery.
(D) It absolutely guarantees an immediate end to all global bycatch.

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2025

258. All of the following are universally classified as output controls EXCEPT:
(A) Setting a fleet-wide competitive Total Allowable Catch (TAC)
(B) Imposing individual vessel trip limits strictly by weight
(C) Restricting the maximum allowable engine horsepower
(D) Mandating individual transferable catch quotas

2025

259. A scientific council strictly models target $F_{\{MSY\}}$ against current biomass to output a ton limit of 5,000 tons. This application establishes the:
(A) Biologically determined Total Allowable Catch
(B) Maximum spatial boundary of the territorial waters
(C) Strict architectural dimensions of the vessel hold
(D) Ultimate economic value of the fleet

2008

260. Which statement regarding strict competitive TACs (without individual allocation) is completely incorrect?
(A) They frequently precipitate a dangerous, high-speed "race for fish."
(B) They often result in massive, temporary market gluts followed by completely closed seasons.
(C) They lead to severe overcapitalization as vessels compete to catch the limit fastest.
(D) They completely and inherently eliminate all bycatch and ecological damage.

2016

261. What is the single best socioeconomic justification for transitioning a fishery from a competitive TAC to a fully allocated ITQ system?
(A) It ends the "race for fish," improving safety and spreading landings.
(B) It perfectly abolishes the natural laws of supply and demand.
(C) It instantly prevents all ocean warming and climatic shifts.
(D) It heavily encourages the deployment of highly unselective ghost fishing gears.

2023

262. From the long-term observation of established ITQ markets globally, an economist can correctly infer that quota frequently tends to:
(A) Mathematically vanish into thin air entirely

9. (B) The maximum biomass an environment can sustainably support
Carrying capacity refers to the maximum biomass of a specific population that an environment can naturally and sustainably support over time under prevailing conditions. This biological limit is determined by available food, shelter, spawning habitats, and predation pressure. Exceeding this threshold leads to density-dependent mortality and reduced individual growth rates within the stock.

10. (A) I and III
Sustainable fisheries management requires maintaining target species at viable reproductive levels and mitigating adverse impacts on the surrounding ecosystem. Focusing solely on short-term economic profits leads to rapid stock depletion and habitat degradation. A balanced, ecosystem-oriented approach ensures both resource longevity and the preservation of critical food web dynamics for future generations.

11. (A) It provides historical baselines and local ecosystem insights.
Integrating traditional ecological knowledge with modern scientific management provides invaluable historical baselines and localized ecosystem insights. This collaborative approach enhances the understanding of long-term environmental patterns, historical fish movements, and species interactions. It fosters community trust, improves regulatory compliance, and complements quantitative stock assessments by filling critical data gaps in data-poor fisheries.

12. (C) Subsidies - Directly decreasing overall fishing effort
Government subsidies typically lower the cost of fishing, which artificially inflates profit margins and incentivizes increased fishing effort rather than decreasing it. This economic distortion leads to fleet overcapitalization and severe overexploitation of resources. Conversely, catch quotas, gear restrictions, and closed seasons function as direct conservation tools to limit mortality and protect spawning stocks.

13. (D) Rate of fish removal by fishing activities.
Fishing mortality is defined as the instantaneous rate at which fish are removed from a population due to commercial, artisanal, or recreational fishing activities. This parameter is separate from natural mortality, which encompasses deaths from predation, disease, and senility. Accurately quantifying fishing mortality is critical for stock assessments and setting sustainable exploitation limits.

14. (C) Somatic growth rate over time
The von Bertalanffy growth equation is a mathematical model widely utilized in fisheries biology to describe how individual fish grow in length or weight over time. It calculates key parameters, including the asymptotic length and the growth coefficient, to estimate somatic development. These metrics are crucial for determining age-structured productivity in stock assessments.

15. (B) Market demand and pricing
The Beverton-Holt dynamic pool model is a strictly biological assessment framework focused on the demographic processes of a fish stock. It incorporates biological parameters such as individual growth rates, natural mortality, recruitment, and age at first capture. Economical variables like market demand, operating costs, and consumer pricing are fundamentally excluded from this specific analytical model.

NODIA

16. (D) Reduced yield per recruit
An increase in the natural mortality coefficient while fishing mortality remains constant reduces the proportion of fish surviving to be harvested. This demographic shift mathematically decreases the expected yield per recruit, as more individuals die from natural causes before capture. Consequently, the overall productivity and potential biomass yield of the fishery are lowered.

17. (A) It is heavily utilized as a relative index of stock abundance.
Catch Per Unit Effort is widely utilized as a standard relative index of stock abundance in fisheries assessment. Under the assumption of constant catchability, changes in this metric are expected to mirror fluctuations in the underlying fish biomass. However, technological advancements and schooling behavior can distort this relationship, necessitating careful calibration in models.

18. (C) Global ocean current speeds
Executing age-structured stock assessments requires specific demographic parameters,

including age-at-maturity, natural mortality, and age-specific catch data. These biological inputs allow scientists to estimate cohorts, recruitment, and fishing mortality over time. While ocean current speeds can influence larval dispersal, they are not standard base parameters required for running age-structured population models.

19. (A) Hyperstability within the fishery data
Hyperstability occurs when commercial Catch Per Unit Effort remains high and stable despite a severe decline in the actual stock biomass. This phenomenon is common in schooling fish species, where modern fish-finding technologies allow fleets to efficiently target remaining aggregations. This mismatch can dangerously mask stock depletion, leading to unexpected fishery collapse.

20. (C) A is true but R is false.
Virtual Population Analysis is a cohort reconstruction technique that calculates historical population abundance sequentially by working backward from observed catches. Because it reconstructs past cohorts using real historical catch data, it does not rely on predictions of future recruitment trends. Thus, the assertion regarding its retrospective calculations is accurate, while the reason is incorrect.

21. (B) How quickly the population responds to depletion and recovers
The intrinsic rate of population increase represents the maximum biological growth rate of a stock under non-limiting conditions. In the Schaefer surplus production model, this parameter directly determines how rapidly a depleted population can recover to carrying capacity when fishing pressure is reduced. It reflects the species' inherent productivity, fecundity, and resilience.

22. (C) Recruitment is always directly and linearly proportional to spawning stock biomass.
The relationship between recruitment and spawning stock biomass is rarely linear because density-dependent factors like competition and cannibalism limit survival at high densities. The Ricker model describes dome-shaped recruitment patterns with declines at high spawner levels, while the Beverton-Holt model describes asymptotic behavior. Environmental fluctuations also introduce significant non-linear variability to recruitment rates.

23. (D) Holistic models do not strictly require age or size structure data.
Holistic surplus production models, like the Schaefer model, treat the entire fish stock as a single, unstructured unit of biomass, relying primarily on simple catch and effort data. In contrast, analytical models like Beverton-Holt require detailed age-specific or size-specific demographic data, including growth, natural mortality, and recruitment, to assess stock dynamics.

24. (A) Total Mortality - Z
In stock assessment mathematics, total mortality is represented by the symbol Z, which is the sum of fishing mortality, denoted as F, and natural mortality, denoted as M. The catchability coefficient is represented by the symbol q. Correctly identifying these standardized mathematical symbols is fundamental for interpreting and executing population dynamics equations.

25. (B) The highest theoretical equilibrium yield continuously taken from a stock
Maximum Sustainable Yield is defined as the largest average catch that can be continuously harvested from a fish stock under constant environmental conditions without impairing its reproductive capacity. This biological reference point occurs when the population is reduced to a level of maximum net growth, typically around half of the virgin biomass.

26. (B) The net profit between total revenue and cost is maximized.
Maximum Economic Yield represents the level of catch and fishing effort that maximizes the net economic profit of the fishery. This point occurs where the marginal revenue of fishing effort exactly equals the marginal cost. Because of operating expenses, this reference point is achieved at a lower level of effort and higher biomass than Maximum Sustainable Yield.

27. (A) Eventually results in the Maximum Sustainable Yield
The reference point represents the specific rate of fishing mortality that, if applied constantly over the long term, will reduce the stock biomass to the level that produces the Maximum Sustainable Yield. Managing a fishery at this target mortality rate aims to optimize harvest output

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while preventing biological overexploitation of the stock.

28. (C) Dissipation of potential economic rent
Operating a fishery with effort levels exceeding the Maximum Economic Yield but below the Maximum Sustainable Yield results in the progressive dissipation of potential economic rent. In this zone, the high costs associated with additional fishing effort outweigh the economic value of the marginal catch increase, reducing the overall profitability and economic efficiency of the fleet.

29. (D) B_{MSY} is typically around half of B_0
In standard surplus production models, such as the symmetric logistic Schaefer model, the biomass that yields the Maximum Sustainable Yield is mathematically determined to be exactly half of the virgin biomass, or carrying capacity. This assumes that population growth rate peaks at intermediate densities, allowing the highest sustainable extraction of biomass to occur at this level.

30. (A) P-3, Q-4, R-1, S-2
Reference points align with distinct biological and economic management focuses. Maximum Sustainable Yield represents the peak continuous physical harvest, whereas Maximum Economic Yield targets peak economic profit. The biomass at Maximum Sustainable Yield represents the target population level for maximum yield, while the conservative reference point serves as a biological target based on marginal yield considerations.

31. (B) $F_{\{tar \geq t\}}$
Limit reference points define boundaries that should not be crossed to prevent biological collapse, including minimum acceptable biomass levels and crash mortality rates. Conversely, target reference points represent desirable outcomes that management actively strives to achieve, such as a target fishing mortality rate. Target levels are set conservatively to avoid inadvertently triggering limit thresholds.

32. (D) Fishing effort to expand further beyond MEY and MSY
Heavy government fuel subsidies reduce the operational costs of fishing, which artificially inflates short-term profitability. In an open-access fishery, this shift encourages additional vessels to enter and existing fleets to fish longer. Consequently, the bioeconomic equilibrium is pushed further beyond both economic and sustainable biological thresholds, exacerbating overcapitalization and stock depletion.

33. (A) It assumes multi-species interactions are the primary driver of yield.
The concept of Maximum Sustainable Yield is built on single-species surplus production models. These frameworks assume the targeted stock operates in isolation, ignoring multi-species trophic interactions and habitat dependencies. They assume a steady-state environment where population growth responds predictably to density reductions, treating the stock as a single independent biological unit.

34. (C) Cost of extra effort exceeds revenue of the extra catch.
The fishing effort required to reach Maximum Economic Yield is lower than that for Maximum Sustainable Yield because of diminishing economic returns. As effort increases toward sustainable limits, the marginal revenue of the extra catch declines while operating costs rise linearly. Therefore, the point of maximum net profit is reached before physical yield is fully maximized.

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35. (A) The stock is mathematically overfished.
When a comprehensive stock assessment indicates that the current biomass has fallen significantly below the biomass level that supports Maximum Sustainable Yield, the stock is classified as overfished. This biological status indicates that the population has been depleted by excessive fishing mortality and requires immediate recovery measures to rebuild its reproductive capacity.

36. (D) It provides a more conservative buffer against overfishing.
The reference point represents the fishing mortality at which the marginal increase in yield per recruit is only ten percent of that in an unexploited fishery. Compared to the mortality rate that maximizes yield, this reference point is more conservative. It leaves more biomass in the water, offering a safer buffer against environmental uncertainty and recruitment failure.

alter their geographic distributions to remain within their preferred thermal ranges. This behavioral adaptation forces species to migrate poleward toward cooler latitudes or descend into deeper, colder waters. These shifts alter local ecosystem dynamics and disrupt traditional fishing grounds.

75. (A) The physical calcification process in mollusks and corals
Ocean acidification reduces the concentration of carbonate ions in seawater, which directly impairs the calcification process in marine organisms like mollusks, crabs, and corals. These species rely on carbonate ions to build and maintain their calcium carbonate shells and skeletons. Weakened skeletal structures increase their vulnerability to predation, storm damage, and physiological stress.

76. (D) Reduced reproductive success and localized extinctions
Increased sea surface temperatures in tropical regions can push fish stocks beyond their optimal thermal tolerances. This heat stress reduces metabolic efficiency, lowers dissolved oxygen levels, and impairs reproductive performance, leading to reduced spawning success. Over time, these negative impacts can cause localized extinctions of vulnerable species and shift species distributions.

77. (B) Decreased structural complexity reduces habitat for reef-associated reef fish.
Coral bleaching driven by thermal stress leads to widespread coral mortality, which subsequently causes the physical breakdown of the reef structure. This loss of structural complexity reduces the availability of shelter, breeding grounds, and feeding areas for reef-associated fish species. Consequently, reef fish abundance and biodiversity decline, impacting small-scale coastal fisheries.

78. (D) Global reduction in Illegal, Unreported, and Unregulated (IUU) fishing
Climate change impacts fisheries by altering ocean current patterns, shifting plankton blooms, and increasing the frequency of extreme weather events that disrupt fishing operations. However, it does not cause a global reduction in illegal, unreported, and unregulated fishing. Managing illegal fishing requires international policy enforcement and surveillance, which are independent of climatic changes.

79. (A) Geographic stock redistribution driven by climate change
When a fish stock shifts its distribution across national boundaries due to warming ocean temperatures, regional management bodies must modify historical quota allocations. This administrative adjustment is a direct response to geographic stock redistribution driven by climate change. It highlights the need for international cooperation to manage transboundary resources as they move into new jurisdictions.

80. (A) P-3, Q-4, R-2, S-1
Climate stressors correspond directly with specific biological impacts. Ocean acidification drives the dissolution of pteropod shells by reducing carbonate ions, while sea surface warming triggers the poleward shift of species ranges. Sea level rise degrades coastal mangrove nursery habitats, and deoxygenation leads to habitat compression for active pelagic predators that require oxygen-rich waters.

81. (A) Warming waters possess a higher capacity to hold dissolved oxygen.
The assertion that warming waters possess a higher capacity to hold dissolved oxygen is incorrect, as oxygen solubility declines as water temperature increases. Climate change triggers phenological mismatches between larval fish and their planktonic prey, alters the distribution of migratory species, and drives ocean acidification, which threatens the foundational bases of marine food webs.

82. (C) Utilizing dynamic ocean management and flexible spatial closures
To address shifting fish stocks driven by thermal changes, the most proactive management strategy is utilizing dynamic ocean management. This approach uses real-time biological and oceanographic data to establish flexible, temporary spatial closures rather than relying on rigid, static boundaries. This flexibility tracks shifting target species and bycatch risks, ensuring effective conservation.

83. (A) Tropical developing nations
Projections indicate that fisheries in tropical developing nations are highly vulnerable to severe catch declines driven by climate change. These

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is identified by assessing spawning stock biomass, showing that the adult population is too depleted to produce sufficient offspring to sustain the fishery.

47. (C) Economic waste is occurring due to redundant fishing effort.
When a fishery suffers from severe overcapitalization, managers can infer that significant economic waste is occurring due to redundant fishing effort. This situation arises when there are far more vessels and gear than necessary to harvest the sustainable catch. Consequently, potential resource rent is completely dissipated, and fleet profitability is reduced to marginal levels.

48. (A) Remaining vessels may increase their individual effort, negating capacity reduction.
Vessel buyback programs intended to reduce overcapacity often fail because of effort creep. The remaining vessel owners frequently reinvest their funds to upgrade their ships, increase horsepower, or adopt superior fish-finding technologies. This compensation mechanism increases the individual fishing power of the remaining fleet, which can completely negate the initial capacity reductions.

49. (B) The continued catching of marine life by lost or abandoned fishing gear.
Ghost fishing is defined as the non-selective and continuous capture of marine organisms by lost, discarded, or abandoned fishing gear. Once gear like gillnets or traps enters the water column or settles on the seafloor, it remains functional for decades. This process causes unquantified mortality of commercial and non-commercial species, threatening marine biodiversity.

50. (B) Initial bait attracts catch → Catch dies and becomes bait → Cyclic continuous capture → Eventual gear degradation
The typical cycle of ghost fishing in lost traps begins when the initial bait attracts target species. Once captured, these animals eventually die of starvation or predation, transforming into new bait that attracts subsequent scavengers and fish. This cyclic process of capture and decay continues indefinitely until the structural integrity of the gear finally degrades.

51. (B) Bottom-set gillnets and traps
Bottom-set gillnets and traps are recognized globally as the gear types producing the highest mortality rates through ghost fishing. Made of highly durable synthetic plastics, these passive gears retain their structural shape and catching efficiency long after being lost. They continue to entangle demersal fish, crustaceans, and marine mammals, leading to severe localized ecological impacts.

52. (C) It causes the net to become heavier and collapse to the seafloor, temporarily halting fishing.
When a lost gillnet accumulates dead fish and marine debris, the added weight eventually exceeds the buoyancy of the floats. This causes the net to collapse onto the seafloor, which temporarily halts active ghost fishing. However, as the trapped organic matter decays and is consumed by scavengers, the net can rise again, resuming its catching cycle.

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53. (A) Installing biodegradable escape panels or hinges
Installing biodegradable escape panels or hinges is a primary technical mitigation strategy designed to prevent ghost fishing in traps. These panels are secured with natural fibers, such as untreated cotton twine, which break down rapidly in seawater. Once the twine degrades, the panel opens, allowing captured marine life to escape freely if the trap is lost.

54. (D) Strict adherence to spatial marine protected areas
The primary causes of gear loss leading to ghost fishing include severe weather conditions, interactions with marine mammals, and spatial conflicts with active towed gears like bottom trawlers. Adhering to spatial marine protected areas does not cause gear loss; rather, it reduces gear conflicts and limits the overall deployment of gear in sensitive, high-risk habitats.

55. (B) Trace lost gear back to owners to enforce accountability and recovery
Implementing mandatory gear marking systems allows authorities to trace lost, abandoned, or discarded fishing gear back to its original owners. This traceability establishes clear accountability, discourages deliberate disposal of worn gear at sea, and facilitates retrieval operations. It serves

as a crucial policy tool for reducing the overall volume and impact of marine debris.

56. (C) Biodegradable twine completely prevents gear from ever being lost.
The statement that biodegradable twine completely prevents gear from being lost is incorrect. Biodegradable components do not prevent the physical loss of gear due to storms or conflicts; rather, they ensure that once lost, the gear quickly loses its catching capacity. Synthetic materials like nylon resist degradation for decades, making modern ghost fishing particularly severe.

57. (D) Drift gillnet
Drift gillnets rely on a vertical wall of synthetic webbing suspended in the water column to capture fish by enmeshing them. When lost over structures like reefs, these nets easily snag on coral and rocks, remaining suspended and fully functional. This positioning enables them to continuously ghost-fish pelagic and demersal marine organisms for extended periods.

58. (A) Unquantified hidden mortality that distorts stock assessments and reduces future yields
From an economic perspective, ghost fishing represents a significant external cost that results in unquantified, hidden mortality. This undocumented loss of biomass distorts scientific stock assessments, leading to inaccurate quota settings and reduced future yields. This inefficiency reduces the long-term economic profitability of legitimate commercial fleets by silently depleting the resource base.

59. (C) Reduced gear strength and frequent need for replacement, increasing fisher costs.
A major disadvantage of replacing all synthetic fishing nets with rapid-biodegradable materials is the reduced durability of the gear. Biodegradable materials degrade quicker in seawater, weakening the net and requiring more frequent repairs or replacements. This increased operational cost can place a significant financial burden on fishers, leading to resistance in adopting these technologies.

60. (A) I, III, and V
Practical measures designed to mitigate ghost fishing include mandatory gear marking, regular derelict gear recovery programs, and implementing biodegradable escape panels in traps. Acoustic pingers are used as marine mammal deterrents on active nets to prevent bycatch, while a global ban on all motorized fishing is an impractical measure that does not target gear loss.

61. (A) Physical alterations like damming and channelization
Anthropogenic habitat degradation in riverine systems is most frequently initiated by physical engineering alterations, such as the construction of dams, levees, and channelization. These structural modifications disrupt the natural flow of water, block fish migration routes, and isolate river channels from their adjacent floodplains. Consequently, they alter the biological, chemical, and physical dynamics of the river.

62. (D) Anadromous and catadromous migratory species
River damming poses an existential biological threat to anadromous and catadromous migratory species. These fishes must migrate between freshwater rivers and marine environments to complete their life cycles. Physical barriers like dams block their longitudinal migration pathways, preventing them from reaching crucial spawning or feeding grounds, which can lead to rapid localized population extinctions.

63. (A) Transferring alien invasive species and altering endemic aquatic biodiversity
River interlinking projects are heavily criticized by aquatic ecologists due to the high risk of transferring alien invasive species and pathogens between previously isolated river basins. By artificially connecting distinct watersheds, these projects disrupt natural geographic barriers, leading to increased competition, hybridization, and the potential displacement of endemic species, which severely alters local aquatic biodiversity.

64. (D) Reduced lateral connectivity with crucial floodplain wetlands
Drastic flow alterations and reductions in discharge directly reduce the lateral connectivity of a river with its adjacent floodplain wetlands. Seasonal floods are essential for inundating floodplains, which function as critical nursery and feeding grounds for many riverine fish species. Restricting these flows prevents fish from accessing these habitats, severely impairing recruitment and productivity.

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65. (B) Fish passes and ladders
Fish passes and ladders are engineering structures designed to restore longitudinal connectivity in rivers regulated by dams or weirs. These passages provide a series of stepped pools that allow fish to bypass physical barriers and migrate upstream. Restoring this connectivity is critical for the survival of migratory species that rely on accessing specific spawning habitats.

66. (D) Immediate reversal of the marine food web trophic cascade
The construction of large dams alters downstream thermal regimes, traps nutrient-rich sediments, and converts flowing lotic habitats into standing lentic reservoirs. However, these riverine modifications do not cause an immediate reversal of marine food web trophic cascades. Trophic cascades in marine systems are driven by different oceanic factors and are not directly altered by inland damming.

67. (D) Mimic natural hydrological cues to trigger fish spawning migrations
Releasing controlled artificial floods from dams during the monsoon season is designed to mimic natural hydrological cues. Many riverine fish species, particularly rheophilic spawners, rely on sudden increases in water flow and velocity to trigger their spawning migrations. Recreating these seasonal discharge patterns helps restore reproductive cues and supports recruitment in regulated river systems.

68. (A) Habitat modifications have zero impact on benthic macroinvertebrate functional groups.
The assertion that habitat modifications have zero impact on benthic macroinvertebrates contradicts the River Continuum Concept. This ecological model states that physical variables control the distribution of functional feeding groups along a river. Anthropogenic disruptions like dams reset this continuum by trapping organic matter, altering water temperatures, and changing downstream community composition and energy pathways.

69. (B) It causes hypersalinity and alters nursery habitat suitability for euryhaline species.
Reduced freshwater discharge due to upstream damming alters the delicate balance of estuarine environments. This reduction allows marine saltwater to intrude further inland, causing hypersalinity and disrupting natural salinity gradients. This shift degrades the suitability of estuaries as nursery habitats for euryhaline species, which rely on low-salinity brackish waters to protect their developing larvae and juveniles.

70. (C) A is true but R is false.
Large dams act as sediment traps, significantly reducing the transport of nutrient-rich sediments and organic material to coastal waters. Because marine primary productivity in coastal zones depends on these riverine nutrient inputs, this reduction declines coastal productivity and decreases fisheries yields. Therefore, the assertion regarding nutrient trapping is true, while the reason is false.

71. (A) Auto-stocking from the main river will be severely impaired or stopped.
Isolating floodplain wetlands from the main river channel using flood-control embankments prevents the lateral migration of fish. This disruption blocks the natural process of auto-stocking, where wild riverine fish and larvae enter the wetlands during seasonal floods. Consequently, recruitment is impaired, species richness declines, and the productivity of these wetland fisheries is severely reduced.

72. (C) It reduces the total volume of water available for agricultural irrigation and hydropower.
The primary disadvantage of maintaining environmental flows in regulated rivers is the socioeconomic trade-off. Allocating a minimum volume of water to sustain ecological functions and downstream fish habitats reduces the volume available for agricultural irrigation, municipal use, and hydroelectric power generation. This allocation challenge requires balancing ecological conservation with human water demands.

73. (A) Carbon dioxide
Ocean acidification is defined as the sustained decline in oceanic pH, driven primarily by the absorption of anthropogenic carbon dioxide from the atmosphere. When carbon dioxide dissolves in seawater, it reacts to form carbonic acid, which releases hydrogen ions and reduces pH. This chemical shift alters the chemistry of the oceans, threatening marine life.

74. (C) Migrate poleward or to deeper waters
As global climate change increases sea surface temperatures, marine fish populations generally

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37. (B) Fish are harvested at too small a size before reaching optimal growth.
Growth overfishing occurs when fish are caught at an average size that is smaller than the optimum size needed to maximize the yield per recruit. Harvesting individuals before they can complete their rapid somatic growth phase results in a lower total catch weight. This is typically mitigated by increasing the minimum mesh size of fishing gears.

38. (C) Reduction of the adult population to a point where reproduction is impaired.
Recruitment overfishing occurs when the spawning stock biomass is depleted to such low levels that the population's reproductive capacity is compromised. This severe biological state results in a drastic decline in the number of offspring entering the fishery. It is characterized by sustained recruitment failure and requires immediate reductions in fishing mortality to rebuild adult stocks.

39. (D) The fleet's harvesting capability significantly exceeds the sustainable yield of the stock.
Fishing fleet overcapacity describes a situation where the collective harvesting capability of a fleet exceeds the sustainable yield of the targeted fish stocks. This structural imbalance means that if the fleet operated at full capacity, it would rapidly deplete resources. It drives regulatory stress, shortens fishing seasons, and leads to massive economic inefficiencies.

40. (A) I, II and IV
Key indicators of recruitment overfishing include a sharp decline in spawning stock biomass, a sequence of very poor year-classes entering the fishery, and a geographic contraction of the stock's range. An increase in the average size of fish caught is not an indicator; rather, overfishing typically causes the average size of landed fish to decrease over time.

41. (A) Unrestricted vessel construction subsidies
Unrestricted vessel construction subsidies directly worsen global fleet overcapacity by artificially reducing the capital costs of building new ships. This financial support shields operators from market realities, encouraging continued fleet expansion even when fish stocks are declining. In contrast, individual transferable quotas and rights-based management help align fleet capacity with sustainable harvest limits.

42. (C) A rapid onset or worsening of growth overfishing.
Reducing codend mesh sizes allows a trawl fleet to retain smaller, immature fish that would otherwise escape. This change leads directly to growth overfishing, as fish are harvested before they can reach their optimal somatic growth potential. This practice reduces the average size of the catch and lowers the long-term sustainable yield of the fishery.

43. (D) Consistently high proportions of mature, large individuals in the catch.
A healthy fishery is characterized by a stable proportion of large, mature individuals in the catch. Conversely, severe overfishing is indicated by a truncation of the age structure, sustained declines in Catch Per Unit Effort, and a decreasing mean length of the landed fish. Finding high proportions of mature fish indicates that the spawning stock remains resilient.

44. (B) Mandating larger minimum mesh sizes for gears.
Mandating larger minimum mesh sizes for fishing gear is the most direct regulatory tool to mitigate growth overfishing. This technical measure increases the selectivity of the gear, allowing smaller, immature fish to escape and complete their rapid somatic growth phase. By delaying the age at first capture, this policy maximizes the long-term yield per recruit.

45. (A) Overcapacity means vessels catch exactly the MSY using optimal economic inputs.
The definition stating that overcapacity results in catching exactly the Maximum Sustainable Yield using optimal economic inputs is incorrect. Overcapacity is characterized by excessive harvesting power and redundant capital, which causes severe economic inefficiencies and overexploitation. It leads to shortened fishing seasons, intense pressure on regulatory enforcement, and a major misallocation of financial capital.

46. (D) Assessing whether yield-per-recruit or spawning-stock-biomass is primarily impaired.
Distinguishing between growth and recruitment overfishing requires analyzing which biological process is compromised. Growth overfishing is identified using yield-per-recruit models, showing that fish are harvested before reaching their growth potential. Recruitment overfishing

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regions are expected to experience significant species migrations away from the equator toward higher latitudes. Combined with a high societal dependence on seafood for protein and limited adaptive capacity, these shifts pose major food security risks.

84. (C) It increases fuel consumption, operational costs, and carbon footprints.
Shifting fishing fleet operations to follow thermally migrating fish stocks increases the distance vessels must travel from their home ports. This geographic expansion increases fuel consumption, escalates operational costs, and expands the carbon footprint of the fishery. These economic and environmental challenges can render traditional small-scale operations unprofitable and unsustainable.

85. (A) The incidental capture of non-target species or undersized target species during fishing
Bycatch is defined as the incidental, non-intentional capture of non-target species or undersized target individuals during fishing operations. This occurs because most modern commercial fishing gears, such as trawls and gillnets, are not perfectly selective. Bycatch can include non-commercial fish, marine mammals, seabirds, sea turtles, and juvenile individuals of the targeted species.

86. (C) Discards
Discards are the portion of the catch returned to the sea, dead or alive, after being caught. This practice is driven by economic factors, such as low market value, or regulatory constraints, including minimum size limits or quota restrictions. Discarding can lead to significant unrecorded mortality and alters marine food web dynamics by subsidizing scavengers.

87. (D) Tropical shrimp trawl fisheries
Turtle Excluder Devices were originally developed and mandated for use in tropical shrimp trawl fisheries. Because shrimp trawls operate along the seafloor where sea turtles forage, they historically suffered high turtle mortality. Mandating these deflector grids allows large turtles to escape through a designated opening while retaining the target shrimp in the codend.

88. (A) Alteration of benthic communities, often favoring opportunistic scavengers
Unregulated bottom trawling with high discard rates severely disrupts benthic ecosystems. The physical scraping of the trawl gear damages fragile habitat-forming organisms like sponges and corals, reducing structural complexity. Additionally, discarding large volumes of dead fish onto the seafloor provides a massive food subsidy, altering benthic community structures by favoring opportunistic scavengers over sensitive species.

89. (A) Utilizing differences in behavior and swimming ability between shrimp and finfish
Bycatch Reduction Devices typically function by exploiting the distinct behavioral responses and swimming capabilities of target species versus non-target bycatch. For example, in shrimp trawls, finfish are stronger swimmers and can actively swim upward through escape openings, whereas sluggish shrimp are swept directly into the codend. This difference significantly improves species selectivity.

90. (C) I and III
Discarding dead catch back into the ocean alters food web dynamics by subsidizing marine scavengers on the seafloor. High discard rates are frequently driven by market preferences and strict quota regulations, such as high-grading. Bycatch is not limited to marine mammals and turtles; it also includes non-target fish and juvenile target individuals.

91. (A) Harpoons
Bycatch Reduction Devices are technical modifications integrated into non-selective, active towed gears like otter, beam, and shrimp trawls to facilitate the escape of non-target species. Conversely, harpoons are highly selective, target-specific gears operated manually. Because harpoon fishers target individual animals visually, this fishing method generates virtually zero bycatch, eliminating the need for such devices.

92. (C) The TED escape flap is sewn shut or obstructed by debris.
If a fishery mandated to use Turtle Excluder Devices continues to experience high turtle mortality, the most likely issue is that the escape flap is sewn shut or obstructed. This physical obstruction prevents turtles from exiting the net

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through the escape opening, forcing them into the codend where they drown. Ensuring proper maintenance is essential for effective mitigation.

93. (A) It is technologically possible to achieve zero bycatch in all commercial fisheries.
The assertion that it is technologically possible to achieve zero bycatch in all commercial fisheries is incorrect. Due to overlapping species distributions and gear limitations, some degree of incidental catch is inevitable in commercial fishing. However, bycatch can be reduced using spatial-temporal closures, circle hooks in longline fisheries, and gear modifications like square meshes.

94. (A) Square mesh remains open under tension, allowing better escapement of undersized fish.
Replacing diamond mesh with square mesh in trawl codends improves size selectivity because square meshes remain open under physical tension. In contrast, diamond meshes stretch and close tightly when the net is towed, trapping small fish. Keeping the mesh shape open allows undersized and juvenile fish to escape through the openings, reducing growth overfishing.

95. (B) Air exposure time, catch volume, and thermal stress on deck
Scientific studies demonstrate that the survival rate of discarded bycatch depends on several handling factors. Key variables include air exposure time on deck, total catch volume inside the net, and thermal stress from air temperature differences. Minimizing sorting times, reducing physical abrasion, and keeping organisms wet can significantly lower discard mortality rates.

96. (A) They force vessels to halt fishing early if their holds fill with low-value choke species.
A major disadvantage of implementing mandatory landing obligations, or 'no-discard' policies, is the 'choke species' effect. Under these regulations, once a vessel exhausts its quota for a low-value bycatch species, it must cease all fishing operations, even if it has remaining quota for the target species. This constraint can cause severe economic losses.

97. (B) Establishes itself, spreads rapidly, and causes ecological or economic harm.
An invasive aquatic species is defined as an introduced, non-native species that successfully establishes a self-sustaining population in a new environment, spreads rapidly, and causes ecological, environmental, or economic harm. These species typically outcompete native fauna for resources, disrupt local food webs, and can alter habitat structures, leading to declines in native biodiversity.

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98. (C) Discharge of ship ballast water
The discharge of ship ballast water is recognized as the most common vector for the accidental introduction of marine invasive species. Large cargo ships take in ballast water for stability, inadvertently trapping plankton, larvae, and small fish. When this water is discharged in distant ports, these non-native organisms are released, allowing them to colonize new environments.

99. (A) The replacement of unique local biotas with widespread, often invasive, species.
Biotic homogenization refers to the process where distinct, localized ecosystems lose their unique biological identities and become increasingly similar over time. This ecological shift is driven by the introduction and establishment of widespread invasive species, alongside the localized extinction of native endemic species. It reduces global biodiversity and diminishes the structural uniqueness of aquatic communities.

100. (A) Both A and R are true and R is the correct explanation of A.
The introduction of predatory exotic fish often leads to the rapid decline of native species, as demonstrated by the extinction of endemic cichlids in Lake Victoria. This ecological impact occurs because native species typically lack evolutionary adaptations to evade novel, introduced predators. Therefore, both the assertion and the reason are true, with the reason explaining the assertion.

101. (A) Larvae transported across oceans via hull fouling on commercial ships
Larvae transported across oceans via hull fouling represents an accidental introduction of an exotic species, as the transport occurs unintentionally through commercial shipping pathways. In contrast, stocking tilapia in reservoirs, releasing hatchery fish for enhancement, or introducing mosquitofish for biocontrol are intentional actions carried out by managers to achieve specific socioeconomic or ecological goals.

102. (D) The mass extinction of hundreds of endemic haplochromine cichlid species.
The intentional introduction of the predatory Nile perch into Lake Victoria in the mid-twentieth century triggered a major ecological catastrophe. As an apex predator, the Nile perch preyed heavily on native fishes, causing the mass extinction of hundreds of endemic haplochromine cichlid species. This introduction restructured the lake's food web and altered the entire ecosystem.

103. (D) Enhanced genetic integrity of endemic populations
Invasive species pose severe threats to aquatic ecosystems, including trophic disruption, predation on native species, competitive exclusion of indigenous fauna, and the introduction of novel pathogens. They do not enhance the genetic integrity of endemic populations; instead, invasive species often degrade native genetics through hybridization, inbreeding, or the complete displacement of local gene pools.

104. (C) It is impossible to contain the chemical, leading to massive non-target native mortality.
Using chemical piscicides to eradicate invasive species is highly challenging in open river systems because chemicals cannot be easily contained within specific flowing areas. The piscicide is swept downstream, leading to widespread, non-target mortality of native fish, invertebrates, and other aquatic life. Consequently, chemical eradication is generally restricted to isolated lakes or ponds.

105. (A) All exotic species eventually become highly invasive and destructive.
The statement that all exotic species eventually become highly invasive and destructive is incorrect. Many introduced species fail to establish self-sustaining populations or exist in low densities without causing ecological harm. However, some are introduced intentionally for aquaculture, and when a species does become invasive, it can alter nutrients, making marine eradication virtually impossible.

106. (D) Implementing strict biosecurity protocols and using sterile triploid fish
The most effective preventative strategy against the ecological impacts of aquaculture escapes is implementing strict biosecurity protocols combined with rearing sterile triploid fish. Triploid fish possess three sets of chromosomes, rendering them functionally sterile. If they escape into wild habitats, they cannot interbreed with native populations or establish self-sustaining invasive stocks.

107. (B) Genetic introgression if the exotics are closely related to wild native stocks.
Using exotic species in aquaculture introduces a significant risk of genetic introgression if escaped individuals interbreed with closely related wild native stocks. This interbreeding can disrupt local evolutionary adaptations, introduce maladaptive traits, and reduce the overall genetic fitness and resilience of the wild population. Managing this risk requires strict containment and genetic monitoring.

108. (D) The exotic species might shift its diet to consume valuable native flora or fauna.
A critical disadvantage of introducing an exotic species for the biological control of aquatic weeds is the risk of host-switching. Once introduced, the biocontrol agent may expand its diet to consume valuable native flora or fauna instead of the target weed. This dietary shift can disrupt native food webs and cause unintended ecological damage.

109. (A) Unreported
Under the Food and Agriculture Organization definition, the acronym IUU stands for Illegal, Unreported, and Unregulated fishing. These three categories encompass activities that violate national laws or international treaties, fail to report or misreport catch data to relevant management authorities, or are conducted by vessels without nationality in areas without established management measures.

110. (A) Misreporting catch data, such as under-declaring weight or species, to national authorities
Unreported fishing refers to fishing activities that are not reported, or are misreported, to the relevant national or international management authorities, in violation of established laws or regulations. This includes under-declaring the total landed weight, misidentifying species to bypass quotas, or failing to submit logbook data, which introduces significant bias into scientific stock assessments.

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111. (B) II, IV, I, III
The logical operational sequence of Monitoring, Control, and Surveillance begins with registration and licensing to establish legal participation. During active fishing operations, electronic monitoring via Vessel Monitoring Systems tracks spatial compliance. If anomalies are detected, patrol vessels are deployed for physical inspections, which can lead to prosecution and sanctioning of documented violations.

112. (B) It introduces massive bias into catch statistics, invalidating stock assessments.
Chronic illegal, unreported, and unregulated fishing introduces massive bias into catch statistics by hiding the true volume of fish removed from the ocean. Because stock assessment models, like Virtual Population Analysis, rely on accurate catch-at-age data, these unreported removals invalidate biomass estimates. This uncertainty leads to ineffective management and increases the risk of stock collapse.

113. (A) Flags of convenience
The practice of registering a fishing vessel in a foreign country that has lax regulations and minimal enforcement is termed using flags of convenience. Owners use this strategy to bypass strict conservation measures, labor standards, and safety inspections of their home nations. It allows vessels to engage in unregulated fishing with minimal risk of sanctions.

114. (C) Harvesting exact quota limits as prescribed by the management authority.
Harvesting the exact quota limits prescribed by a management authority is a legal and compliant activity, not an IUU practice. Conversely, IUU fishing includes operating inside closed Marine Protected Areas, using prohibited destructive gears like explosives, or fishing on the high seas under a non-member flag of a Regional Fisheries Management Organization.

115. (B) Continuously track vessel location to monitor spatial compliance.
Mandating Vessel Monitoring Systems on fishing vessels is a technical application designed to continuously track vessel location and transmission data. This system allows authorities to monitor spatial compliance, ensuring that vessels do not operate in restricted areas like Marine Protected Areas or closed zones. It serves as a primary tool in modern fisheries surveillance.

116. (D) IUU operators carefully ensure they pay all required national taxes and tariffs.
The statement that IUU operators ensure they pay all required taxes and tariffs is incorrect, as avoiding financial duties is a primary economic driver of illegal fishing. IUU activities are driven by high market demand, weak governance, and limited enforcement resources. Overcapacity in legitimate fleets can also push operators into illegal fishing to cover costs.

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117. (A) The FAO Port State Measures Agreement (PSMA)
The FAO Port State Measures Agreement is the primary international treaty designed to prevent, deter, and eliminate IUU fishing by preventing illicit catch from entering international markets. Under this agreement, signatory states must inspect foreign fishing vessels entering their ports, verify catch documentation, and deny port entry or services to vessels suspected of illegal activities.

118. (B) Artisanal fleets consist of numerous dispersed vessels landing at remote sites.
Artisanal and small-scale fishing sectors are more challenging to regulate and monitor than industrial fleets because they consist of numerous, small, and highly dispersed vessels. These boats land their catches at remote, informal sites along coastlines rather than central ports. This geographical dispersion makes physical inspections and systematic catch recording difficult and resource-intensive.

119. (A) They trace fish from the point of capture to the final market, denying market access to IUU fish.
Catch Documentation Schemes improve fisheries management by tracing seafood products along the supply chain from the point of capture to the retail market. This system requires verifiable documentation at each transfer, preventing illegally caught fish from entering legitimate trade channels. By closing market access to IUU products, these schemes reduce the economic incentives for illegal fishing.

120. (A) I, II, and IV
The prevalence of IUU fishing is driven by a lack of political will, corruption, high operational costs of legal fishing combined with high market prices, and vast, unpatrolled exclusive economic zones. Conversely, achieving 100% observer

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coverage on all vessels is an enforcement tool that deters, rather than increases, illegal fishing activities.

121. (B) Occur both within an Exclusive Economic Zone (EEZ) and in an adjacent high seas area.
Under the United Nations Convention on the Law of the Sea, straddling fish stocks are defined as populations that occur both within an Exclusive Economic Zone and in the adjacent high seas. Because these fish cross geopolitical boundaries, managing them requires international cooperation between coastal states and distant-water nations to prevent overexploitation.

122. (C) Tunas and oceanic sharks
Highly migratory species, as listed in Annex I of the United Nations Convention on the Law of the Sea, include tunas, billfishes, and oceanic sharks. These species travel vast distances across multiple national jurisdictions and the high seas during their life cycles. Consequently, their conservation requires coordinated, international management frameworks across entire ocean basins.

123. (D) Regional Fisheries Management Organizations (RFMOs)
Regional Fisheries Management Organizations are the primary international bodies responsible for coordinating the management of transboundary, straddling, and highly migratory fish stocks. Comprising coastal nations and distant-water fishing states, RFMOs collect scientific data, establish total allowable catch limits, and allocate quotas to member nations to ensure the sustainable use of shared oceanic resources.

124. (A) Overexploitation, as each nation races to maximize its own unilateral catch.
Uncoordinated management of a shared transboundary fish stock by adjacent nations leads to overexploitation. In the absence of cooperative harvest agreements, each country is incentivized to maximize its own unilateral catch before the other depletes the resource. This competitive race for fish exemplifies the Tragedy of the Commons, resulting in stock depletion.

125. (A) Straddling fish stocks and highly migratory fish stocks
The 1995 United Nations Fish Stocks Agreement was established to implement and operationalize the provisions of UNCLOS regarding the conservation of straddling and highly migratory fish stocks. It provides a legally binding framework for cooperative management, requiring states to apply the precautionary approach, share scientific data, and strengthen enforcement through RFMOs.

126. (C) Endemic lake cichlids
Endemic lake cichlids are localized freshwater species confined to specific lakes and do not qualify as transboundary, straddling, or highly migratory stocks. Conversely, species like Atlantic Bluefin Tuna, Oceanic Whitetip Sharks, and South Pacific Jack Mackerel travel across multiple EEZs and international waters, requiring coordinated management by regional bodies.

127. (A) Quota allocation
When a Regional Fisheries Management Organization assigns catch limits for a shared tuna stock to individual member countries based on historical landings, it is applying a quota allocation system. This management tool divides the Total Allowable Catch into country-specific limits, reducing competitive fishing pressure on the high seas and encouraging national compliance.

128. (A) A coastal state claims exclusive sovereign ownership over highly migratory fish even when they enter the high seas.
The statement that a coastal state claims exclusive sovereign ownership over highly migratory fish on the high seas is incorrect. Under UNCLOS, coastal states have sovereign rights within their 200-mile EEZ, but must cooperate with other nations to manage migratory stocks on the high seas. High seas resources are subject to international cooperative agreements.

129. (D) They rely on voluntary compliance and lack robust enforcement.
The most significant challenge regarding Regional Fisheries Management Organizations is that they rely on voluntary compliance by member states and often lack direct enforcement mechanisms. RFMOs do not possess an international police force; instead, they depend on member nations to enforce agreed regulations, which can lead to uneven compliance and illegal fishing.

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167. (A) Share comprehensive scientific catch data and comply with boarding and inspection procedures.
The United Nations Fish Stocks Agreement requires member states to cooperate in managing shared resources by sharing comprehensive scientific catch data. It also establishes enforcement mechanisms, requiring vessels fishing for straddling stocks to comply with high seas boarding and inspection procedures by authorized states to verify compliance with conservation regulations.

168. (A) Their effectiveness is heavily hampered by non-signatory states and uneven domestic enforcement.
A significant operational disadvantage of international treaties like CITES and the UNFSA is that their effectiveness depends on national implementation. Non-signatory states can continue unregulated harvesting, and uneven domestic enforcement or limited monitoring resources in developing nations can allow illegal trade to persist, undermining global conservation efforts.

169. (A) Considers the entire ecological system, including human dimensions, rather than managing single species in isolation.
Ecosystem-Based Fishery Management is an approach that considers the entire ecological system, including human dimensions, rather than managing single species in isolation. It recognizes that target fish populations depend on complex food webs, environmental conditions, and healthy habitats, and seeks to balance sustainable resource extraction with the preservation of ecosystem structures and functions.

170. (A) I and III
Ecosystem-Based Fishery Management aims to sustain entire ecosystem structures and functions while accounting for complex food-web interactions in stock assessments. It does not ignore the socio-economic needs of coastal communities; instead, it integrates human dimensions as a core component of the management framework to ensure balanced and sustainable resource use.

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171. (B) Target-species only management to evaluating multi-species interactions and habitat integrity.
A key paradigm shift from traditional management to Ecosystem-Based Fishery Management involves transitioning from target-species-only assessments to evaluating multi-species interactions and habitat integrity. Traditional methods focus on single-species MSY targets, whereas EBFM evaluates how fishing affects non-target species, trophic relationships, and physical habitats, supporting comprehensive ecosystem resilience.

172. (C) The incidental bycatch of non-commercial benthic invertebrates.
Applying Ecosystem-Based Fishery Management principles requires managers to expand their regulatory focus beyond target species to include the incidental bycatch of non-commercial benthic invertebrates. This broader scope protects seafloor habitats and maintains biodiversity, recognizing that non-commercial species play critical roles in supporting the trophic structures of marine food webs.

173. (D) Humans are recognized as integral, interactive components of the broader ecosystem.
Within the Ecosystem-Based Fishery Management framework, humans are recognized as integral, interactive components of the broader ecosystem. Rather than viewing human activity as an external force to be excluded, EBFM integrates social and economic needs with biological conservation, aiming to sustain both coastal livelihoods and marine ecosystems.

174. (D) Maximizing the single-species yield regardless of bycatch
Ecosystem-Based Fishery Management is built on applying the precautionary approach, minimizing gear impacts on essential fish habitats, and using adaptive management. Maximizing single-species yield regardless of bycatch contradicts these principles, as high single-species extraction can deplete forage fish, generate high discard rates, and disrupt wider food web dynamics.

175. (B) Model complex multi-species trophic interactions for EBFM implementation
Ecopath with Ecosim is a modeling software suite used to simulate complex multi-species trophic interactions and energy pathways within ecosystems. It allows scientists to evaluate how

concerning post-harvest practices and trade. This section emphasizes minimizing post-harvest losses, maintaining seafood safety, and promoting responsible trade. These measures help maximize the economic value of the catch while reducing waste.

140. (A) I, II, IV, and V
The core principles of the FAO Code of Conduct include preventing overfishing and excess capacity, protecting critical habitats, applying the precautionary approach, and recognizing the nutritional rights of communities. Promoting destructive practices contradicts the code, which explicitly advocates for the use of selective and environmentally safe fishing technologies.

141. (A) It forces non-compliant nations to pay mandatory financial reparations.
The statement that the FAO Code of Conduct forces non-compliant nations to pay financial reparations is incorrect. As a voluntary, non-binding instrument, the code lacks enforcement mechanisms and cannot impose financial penalties. Instead, it relies on national adoption, encourages energy-efficient gears, incorporates international agreements, and addresses both conservation and socio-economic equity.

142. (B) It highlights the need for capacity building and financial support to aid their compliance.
The FAO Code of Conduct addresses the challenges of developing nations by highlighting the need for capacity building, technology transfer, and financial assistance. It recognizes that these countries may face resource constraints in implementing comprehensive conservation measures, and calls on the international community to support their transition toward sustainable management.

143. (C) Its integration into the binding domestic laws of individual states.
Because the FAO Code of Conduct is a voluntary framework, its real-world effectiveness depends on its integration into the binding domestic laws of individual states. When nations translate these guidelines into national legislation, they establish enforceable rules, mesh size restrictions, and closed seasons, turning voluntary principles into mandatory compliance.

144. (A) States can adopt specific portions while ignoring difficult measures.
The primary disadvantage of the FAO Code of Conduct relying on a voluntary framework is that nations can adopt easy guidelines while ignoring difficult conservation measures. This cherry-picking can limit the effectiveness of global sustainability initiatives, as countries with weak political will may avoid reducing fleet capacity or implementing expensive monitoring systems.

145. (B) Track the movement of seafood products through all stages of the supply chain
In the seafood industry, traceability is defined as the ability to track the movement of seafood products through all stages of the supply chain, from harvest to consumption. This process involves documenting the vessel, location of capture, landing port, processing facilities, and distribution channels, ensuring transparency and preventing illegal products from entering the market.

146. (B) Chain of Custody
To achieve eco-labeling certification, a fishery must maintain a verifiable Chain of Custody. This process ensures that certified seafood is segregated from non-certified products at every stage of the supply chain, including transport, processing, and retail. It provides consumers with assurance that the product originates from a sustainably managed fishery.

147. (B) Sustainable stocks, minimized impact, and effective management.
The Marine Stewardship Council certification requires fisheries to demonstrate compliance with three core principles: maintaining sustainable target fish stocks, minimizing environmental impacts on the marine ecosystem, and operating under an effective management system. This independent assessment process incentivizes fisheries to adopt sustainable harvesting practices to gain access to certified markets.

148. (A) Access to premium markets and potentially higher price margins
Securing a recognized eco-label, such as Marine Stewardship Council certification, provides compliant fisheries with access to premium markets and higher price margins. Many retailers and consumers prioritize sustainably sourced seafood, allowing certified fisheries to secure preferential market access, enhance their brand

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making it more vulnerable to environmental changes.

185. (B) Continued MTL reduction results in fisheries dominated by plankton.
Daniel Pauly's original hypothesis warned that continued reductions in the Mean Trophic Level of landings would lead to marine ecosystems dominated by low-trophic-level organisms like plankton and jellyfish. This process reflects the progressive depletion of higher-level predatory fish, which can reduce the economic value and ecological stability of global fisheries.

186. (C) A sustained, historical increase in the proportion of caught apex predators.
Indicators of fishing down the food web include a declining Mean Trophic Level of the catch, the serial depletion of large piscivorous species, and gear transitions toward targeting smaller species. Conversely, a sustained increase in caught apex predators indicates a healthy trophic structure, contradicting the fishing down hypothesis.

187. (A) Mean Trophic Level of the catch
Calculating the weighted average of species trophic levels based on their annual landings is the standard method for determining the Mean Trophic Level of the catch. This quantitative index tracks historical changes in catch composition, helping scientists evaluate whether the fishery is shifting its effort toward lower-trophic-level species.

188. (D) MTL calculations from landings always perfectly mirror the actual abundance in the ecosystem.
The assertion that catch-based Mean Trophic Level calculations always perfectly mirror ecosystem abundance is incorrect. Landings are influenced by market demand, fuel prices, and fishing regulations, which can shift catch composition without reflecting true biological changes. Additionally, spatial expansion can temporarily mask localized declines in trophic structures.

189. (A) They lose functional redundancy, making them highly susceptible to environmental shocks and climate change.
Ecosystems depleted of top predators lose functional redundancy and biodiversity, reducing their ecological resilience. Without predators to regulate trophic interactions, these simplified food webs are highly vulnerable to environmental shocks, climate anomalies, and invasive species. This instability can lead to sudden ecosystem collapses and unpredictable fluctuations in fisheries yields.

190. (B) I, II, and III
Standard indicators of fishing down the food web include the collapse of top predator populations, a subsequent increase in mid-trophic level consumer biomass, and a declining trend in the Mean Trophic Level of total landings over time. Rebuilding the original virgin biomass structure contradicts this depletion process.

191. (D) A classic example of mesopredator release
The rapid expansion of small elasmobranch populations following the overfishing of large pelagic sharks is a classic example of mesopredator release. When apex predators are removed, medium-sized predators are freed from top-down control and competitive pressure. This release allows them to expand, which can increase predation on lower trophic levels.

192. (D) Catch data is heavily influenced by economic markets and regulations, which may not reflect true ecosystem abundance.
A limitation of using catch-based Mean Trophic Level as the sole ecosystem indicator is that catch data is influenced by economic markets, consumer preferences, and fishing regulations. Changes in landings may reflect market shifts or gear restrictions rather than actual ecological changes, which can introduce bias into abundance estimates.

193. (A) Ranching releases juveniles into the wild with the explicit intent of harvesting all of them upon their return or maturation.
Artificial sea ranching is distinguished from stock enhancement by its harvest objective. Ranching involves releasing hatchery-reared juveniles into the wild with the intent of harvesting them once they reach commercial size or return to spawn. In contrast, stock enhancement aims to permanently rebuild self-sustaining wild populations.

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194. (B) Carrying capacity
The biological limit to how many hatchery-reared juveniles can be successfully added to a water body is determined by the ecosystem's carrying capacity. This limit is defined by available food, shelter, and environmental conditions. Exceeding

158. (B) Species not necessarily threatened with extinction, but whose trade must be strictly controlled to avoid overutilization.
Species listed under Appendix II of the Convention on International Trade in Endangered Species are not threatened with imminent extinction, but their trade must be strictly controlled to prevent overutilization. Exporting these species requires a permit verifying that the harvest was legal and is not detrimental to the survival of the wild population.

159. (A) Ensure the long-term conservation and sustainable use of straddling and highly migratory fish stocks
The primary legal objective of the 1995 United Nations Fish Stocks Agreement is to ensure the long-term conservation and sustainable use of straddling and highly migratory fish stocks. It operationalizes UNCLOS provisions, requiring states to cooperate through RFMOs, apply the precautionary approach, and implement effective monitoring and enforcement on the high seas.

160. (A) P-3, Q-4, R-2, S-1
International agreements address different marine issues. UNCLOS establishes the foundational framework for maritime zones, including the 200-mile EEZ. The UNFSA provides binding management rules for straddling and migratory stocks on the high seas, while CITES regulates the trade of endangered species. The FAO Code of Conduct provides voluntary guidelines for responsible fishing.

161. (A) Nationals may fish subject to treaty obligations and conservation duties.
Under UNCLOS, the 'Freedom of the High Seas' regarding fishing does not allow unregulated harvesting. Instead, it grants nations the right to fish on the high seas, subject to their treaty obligations and the duty to cooperate with other states in conserving marine resources. This framework requires states to cooperate to manage shared stocks.

162. (C) A massive transfer of marine resource control from open-access international status to coastal state jurisdiction.
The establishment of 200-nautical-mile Exclusive Economic Zones under UNCLOS prompted a massive historic transfer of marine resource control. Previously, about ninety percent of global fish stocks were located in open-access international waters. Placing these areas under national jurisdiction allowed coastal states to regulate fishing effort, set quotas, and exclude foreign fleets.

163. (D) Coastal states must grant adjacent landlocked states ownership of their ports.
UNCLOS requires coastal states to determine the allowable catch in their EEZ, prevent over-exploitation, and promote resource utilization. However, it does not mandate that coastal states grant adjacent landlocked states ownership of their ports. Landlocked nations are granted access to the surplus catch and transit rights, but port ownership remains sovereign.

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164. (A) The export is not detrimental to species survival in the wild.
Listing the Oceanic Whitetip Shark on CITES Appendix II requires exporting nations to issue a Non-Detriment Finding. This document, based on scientific evidence, must demonstrate that the export will not threaten the survival of the species in the wild. This requirement helps regulate international trade and prevent species depletion.

165. (C) If a coastal state does not have the capacity to harvest the entire allowable catch, it must strictly let the surplus die of old age.
The statement that a coastal state must let surplus fish die of old age if it lacks harvesting capacity is incorrect under UNCLOS. The convention dictates that if a state cannot harvest the entire allowable catch, it must grant other nations access to the surplus. Foreign vessels operating in the EEZ must comply with local regulations.

166. (B) UNCLOS mandates cooperation for high seas conservation, which is practically implemented through the establishment of RFMOs.
UNCLOS provides the overarching legal framework that mandates international cooperation for conserving living resources on the high seas. This legal obligation is practically implemented through the establishment of Regional Fisheries Management Organizations. RFMOs serve as the operational vehicles where nations negotiate catch limits, allocate quotas, and coordinate enforcement for shared transboundary stocks.

130. (B) P-2, Q-1, R-4, S-3
Migratory and transboundary stocks are classified by their life histories. Straddling stocks, like cod, move between an EEZ and adjacent high seas. Highly migratory species, such as tunas, cross ocean basins. Anadromous stocks, like salmon, grow in seawater but spawn in freshwater, while catadromous stocks, such as eels, follow the opposite reproductive pattern.

131. (A) The Tragedy of the Commons
Managing fisheries on the high seas is challenging because these areas lie outside national jurisdictions, making them susceptible to the Tragedy of the Commons. Without property rights or binding enforcement, individual nations are incentivized to maximize their harvest, leading to competitive overexploitation and the rapid depletion of shared transboundary resources.

132. (C) It facilitates harmonized regulations and unified stock assessments across the entire watershed.
Forming joint bilateral management bodies for shared riverine fish stocks allows adjacent countries to implement harmonized regulations and conduct unified stock assessments across the entire watershed. This cooperative approach prevents unilateral overexploitation, facilitates the passage of migratory species across borders, and enables coordinated habitat restoration efforts, enhancing the sustainability of the river system.

133. (D) A voluntary framework guiding national and international fisheries policies
The FAO Code of Conduct for Responsible Fisheries is a voluntary, non-legally binding framework adopted to guide nations in developing sustainable fisheries policies. It establishes principles for resource conservation, vessel operations, aquaculture development, and post-harvest trade, encouraging governments to align their domestic legislation with internationally accepted sustainability standards.

134. (B) 1995
The Food and Agriculture Organization Code of Conduct for Responsible Fisheries was unanimously adopted on October 31, 1995. This landmark international instrument was created to address global overfishing and habitat degradation by providing comprehensive, voluntary guidelines. It remains a foundational reference point for national and international sustainable fisheries management.

135. (C) Fisheries management frameworks and principles
Article 7 of the FAO Code of Conduct for Responsible Fisheries is dedicated to establishing comprehensive guidelines for fisheries management. It outlines key principles for setting conservation objectives, applying the precautionary approach, managing fishing capacity, and ensuring stakeholder participation. This article helps states design effective institutional frameworks for sustainable resource use.

136. (B) Improved alignment of national legislation with global sustainability standards
When a nation implements the technical guidelines of the FAO Code of Conduct, it improves the alignment of its domestic legislation with global sustainability standards. This voluntary compliance helps modernize management frameworks, encourages the adoption of selective gears, promotes habitat protection, and strengthens monitoring, contributing to international conservation efforts.

137. (A) The Precautionary Approach
The FAO Code of Conduct strongly advocates for the Precautionary Approach as a central tenet for decision-making under scientific uncertainty. This principle dictates that when data are inadequate or uncertain, managers must act cautiously to prevent stock depletion. The absence of scientific consensus should not be used to delay conservation measures.

138. (D) Military naval operations in the EEZ
The FAO Code of Conduct is a comprehensive instrument that covers capture fisheries management, aquaculture development, post-harvest practices, trade, and integrated coastal zone management. It does not address military naval operations within the Exclusive Economic Zone. Naval activities are governed by separate national defense policies and international maritime laws under UNCLOS.

139. (A) Post-harvest practices and trade
Requiring strict hygiene standards and cold-chain facilities at landing sites applies the guidelines of the FAO Code of Conduct

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fishing pressure on one species impacts predators, prey, and competitors, serving as a primary analytical tool for implementing Ecosystem-Based Fishery Management.

176. (D) EBFM completely discards all previous traditional stock assessment parameters.
The statement that EBFM discards all previous traditional stock assessment parameters is incorrect. EBFM does not replace traditional biological indicators; instead, it builds upon single-species parameters like fishing mortality and biomass by incorporating multi-species trophic interactions, spatial management tools, environmental variables, and socio-economic data.

177. (A) Overharvesting starves dependent apex predators and seabirds.
Managing forage fish populations under EBFM is critical because these species serve as the primary trophic link between plankton and higher predators. Overharvesting forage fish can deplete the prey base, starving dependent apex predators, marine mammals, and seabirds. Maintaining adequate forage biomass is essential for sustaining the wider marine food web.

178. (B) Define ecosystem boundaries → Identify key stakeholders → Assess ecological and socio-economic risks → Develop integrated management plans
The logical planning sequence for Ecosystem-Based Fishery Management begins with defining clear ecological boundaries and identifying key stakeholders. Managers then assess ecological and socio-economic risks, evaluating potential impacts on habitats and communities. This assessment guides the development of integrated management plans that balance conservation with sustainable resource use.

179. (D) Iterative, flexible adaptive management frameworks.
Because marine ecosystems are highly complex and subject to environmental uncertainties, Ecosystem-Based Fishery Management must rely on iterative, flexible adaptive management frameworks. This approach allows managers to monitor ecosystem indicators, evaluate the outcomes of management actions, and adjust regulations in response to new scientific information or changing environmental conditions.

180. (D) The massive requirement for comprehensive multi-disciplinary data and institutional capacity.
A major practical hurdle in implementing Ecosystem-Based Fishery Management in developing coastal nations is the high requirement for multi-disciplinary data and institutional capacity. EBFM requires monitoring trophic webs, habitat conditions, and socio-economic indicators. Gathering and analyzing this information can challenge agencies with limited funding, scientific personnel, and monitoring resources.

181. (A) Fisheries progressively shift from targeting large apex predators to harvesting smaller, lower-trophic-level species.
Fishing down the marine food web describes the historical process where fisheries deplete large, long-lived, high-trophic-level predatory fish, such as cod and tuna. Consequently, fleets shift their target effort toward smaller, short-lived, lower-trophic-level species, including planktivorous fish and invertebrates, altering the overall catch composition.

182. (D) Mean Trophic Level (MTL)
The standard metric used to quantify the ecological process of fishing down the food web is the Mean Trophic Level of the catch. This indicator calculates the average trophic position of landed species, weighted by their catch volume. A declining trend in this index indicates a progressive loss of top predators.

183. (A) A trophic cascade
A trophic cascade is an ecological phenomenon triggered by the removal of top predators, which releases lower trophic levels from predatory control. This removal can lead to a sudden explosion in the biomass of mid-level consumers, who then overconsume primary producers, restructuring the food web and altering the entire ecosystem.

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184. (D) Profound restructuring of the lower trophic web, often destabilizing the ecosystem
The complete functional removal of top marine predators causes a profound restructuring of the lower trophic web. Without apex predators to regulate prey populations, mid-level consumers can expand rapidly, overgrazing primary producers and habitat-forming species. This trophic cascade destabilizes the ecosystem,

reputation, and offset the costs associated with the certification process.

149. (B) Stock sustainability, ecosystem impact, and effective governance
The three core pillars of the Marine Stewardship Council standard are stock sustainability, ecosystem impact, and effective governance. These criteria ensure that the targeted fish population is healthy, the fishing activities do not cause long-term damage to the wider marine habitat or non-target species, and the fishery operates under a transparent, legally compliant management framework.

150. (A) Both A and R are true and R is the correct explanation of A.
Seafood traceability systems reduce the prevalence of illegal, unreported, and unregulated fishing by requiring verifiable documentation at each step of the supply chain. This documentation prevents illegal catch from being mixed with legal landings, closing market access for IUU operators. Therefore, both the assertion and the reason are true, and the reason explains the assertion.

151. (C) Biological yield-per-recruit models.
Seafood traceability is supported by tools like catch certificates, electronic logbooks, RFID tags, blockchain technology, and DNA barcoding for species verification. These systems verify product origins and supply chain movements. Conversely, biological yield-per-recruit models are mathematical tools used to estimate optimal harvest sizes and mortality rates, playing no role in product traceability.

152. (A) Seafood fraud and mislabeling
Using rapid DNA barcoding at retail markets allows inspectors to verify the exact species of a seafood product. This application addresses seafood fraud and mislabeling, where low-value fish are sold as premium species. Preventing this fraud protects consumers, supports honest fishers, and prevents the illegal trade of protected or overfished marine species.

153. (A) Eco-labels mathematically guarantee that the certified fishery causes zero mortality to any marine organism.
The statement that eco-labels guarantee zero mortality to any marine organism is incorrect, as all commercial fishing causes some mortality. Instead, eco-labeling harnesses consumer purchasing power to incentivize sustainable practices, although the certification process is rigorous and expensive. Chain of custody verification ensures that certified fish are not mixed with uncertified catch.

154. (A) It protects local fishers from unfair competition with illegal imports.
Traceability frameworks provide a significant socio-economic benefit by protecting local, law-abiding fishers from unfair market competition with cheap, illegally caught imports. By requiring documentation for all imported seafood, these systems prevent IUU products from depressing local market prices, ensuring that fishers who adhere to sustainable regulations receive fair economic returns.

155. (C) Small-scale, data-poor artisanal fisheries in developing nations
The high financial cost of the Marine Stewardship Council assessment process creates a significant barrier for small-scale, data-poor artisanal fisheries in developing nations. These fisheries often lack the capital, extensive scientific data, and institutional support required to complete the certification. Consequently, they are excluded from lucrative eco-labeled export markets.

156. (C) It is largely ineffective in markets where consumers prioritize low price over environmental concerns.
A limitation of relying on consumer-driven eco-labeling is its limited effectiveness in markets where consumers prioritize low prices over environmental sustainability. In many developing regions, economic constraints make eco-labeled products less competitive. Therefore, consumer demand alone cannot secure global fisheries conservation, highlighting the need for strong national regulations.

157. (A) 200 nautical miles from the baseline
Under the United Nations Convention on the Law of the Sea, a coastal state's Exclusive Economic Zone extends up to 200 nautical miles from its coastal baseline. Within this zone, the state has sovereign rights to explore, exploit, conserve, and manage the living and non-living natural resources found in the waters and seafloor.

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this threshold leads to density-dependent mortality, reducing the survival of both stocked and wild fish.

195. (B) Severe density-dependent competition with wild conspecifics for limited food.
Releasing millions of hatchery fry into an already populated water body can trigger severe density-dependent competition with wild populations for limited food and shelter. This resource limitation can reduce growth rates, increase natural mortality, and displace wild juveniles from their preferred nursery habitats, potentially undermining the goals of the stocking program.

196. (A) Outbreeding depression and a severe reduction in the genetic fitness of the wild stock
Continuous interbreeding between hatchery fish and wild populations can lead to outbreeding depression and a reduction in the genetic fitness of the wild stock. Hatchery fish are often adapted to artificial conditions, and when they breed with wild fish, they can disrupt local genetic adaptations, lowering survival and reproductive success.

197. (B) Exposing juveniles to simulated predators and natural prey before release (behavioral conditioning)
To improve the post-release survival of enhanced stocks, managers use behavioral conditioning, such as exposing juveniles to simulated predators and natural live prey before release. This training helps hatchery fish develop essential predator-avoidance and foraging skills, reducing post-release mortality and improving the efficiency of stocking programs.

198. (D) Guaranteed permanent restoration of the virgin ecosystem structure
Stock enhancement programs carry ecological risks, including pathogen transmission, genetic alteration of wild stocks, and resource competition. They do not guarantee the permanent restoration of the virgin ecosystem structure. Stocking alone cannot resolve the underlying causes of decline, such as habitat degradation, water pollution, or excessive fishing mortality.

199. (B) Density-dependent growth limitation in the marine phase
Releasing more salmon smolts without increasing adult biomass demonstrates density-dependent growth limitation during the marine phase. When the population exceeds the ocean's carrying capacity for that species, individual food availability declines. This resource limitation reduces growth rates, resulting in smaller returning adults without increasing the overall harvested biomass.

200. (A) Both A and R are true and R is the correct explanation of A.
Hatchery operations often rely on a small number of broodstock, which can cause a genetic bottleneck in the offspring. This restricted genetic pool reduces the diversity and adaptive capacity of the released fry, making them more vulnerable to environmental changes. Therefore, both the assertion and the reason are true, and the reason explains the assertion.

201. (B) The natural environment has an infinite carrying capacity for target species.
The assumption that the natural environment has an infinite carrying capacity for target species is incorrect, as all ecosystems have biophysical limits. Successful stock enhancement requires recognizing these boundaries, as hatchery-reared fish often exhibit poor survival skills and require comprehensive monitoring to verify the return rate of stocked individuals.

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202. (B) Utilizing mass marking techniques (e.g., coded wire tags, thermal otolith marks) to strictly quantify the proportion of hatchery fish in the final harvest.
The most reliable scientific method to evaluate a sea ranching program is utilizing mass marking techniques, such as coded wire tags or thermal otolith marks. These marks allow researchers to identify hatchery fish in the commercial catch, enabling them to quantify return rates and assess the economic viability of the program.

203. (B) The economic viability of the enhancement program is highly dependent on the cost of rearing versus the market value of the harvested adults.
If a prawn release program yields a return rate of only 0.5% in the commercial catch, its economic viability depends on the cost of hatchery rearing versus the market value of the harvested adults. If production costs exceed the economic value of the recaptured prawns, the enhancement program may not be financially sustainable.

282. (C) Massive, small-meshed indiscriminate bottom trawls
Selective gears include specialized hook-and-line, precisely spaced gillnets, and traps with escape gaps, which target specific sizes or species. Conversely, massive, small-mesh bottom trawls are highly non-selective, capturing organisms indiscriminately regardless of size or species, which can lead to high bycatch rates and growth overfishing.

283. (A) Eliminate the complex threat of ghost fishing if the pot is irrevocably lost
Mandating biodegradable escape panels held with natural twine in traps is designed to eliminate the threat of ghost fishing if the gear is lost. Once the natural twine degrades in seawater, the panel opens, providing a clear exit for captured marine organisms and preventing continuous, cyclic mortality inside the trap.

284. (D) Implementing smaller, extremely fine mesh sizes mathematically guarantees the highest possible long-term sustainable yield.
The assertion that smaller mesh sizes guarantee the highest long-term yield is incorrect, as fine meshes lead to growth overfishing by capturing immature juveniles. Gear selectivity is influenced by fish girth, and eumetric curves demonstrate that optimizing both fishing mortality and the age of first capture is essential for sustainable yields.

285. (A) Maximization of yield per recruit by strictly preventing the harvest of sub-optimal juveniles
The primary biological objective of enforcing eumetric fishing conditions is maximizing the yield per recruit by preventing the harvest of sub-optimal, immature juveniles. By delaying capture until fish have completed their rapid growth phase, this management strategy optimizes the biomass harvested relative to the number of individuals entering the fishery.

286. (D) The gear possesses highly precise size selection, sharply differentiating between slightly undersized and strictly legal fish.
A steep and sharp gear selectivity ogive indicates that the gear possesses highly precise size selection. This sharp transition shows that the gear efficiently differentiates between slightly undersized fish, which escape, and legal-sized individuals, which are retained, directly allowing managers to target specific cohorts with high accuracy.

287. (C) It suffers from lower physical endurance and higher manufacturing costs.
While square mesh codends improve size selectivity by remaining open under tension, a major disadvantage is their lower physical endurance and higher manufacturing costs. Square meshes experience uneven physical wear and can distort over time, requiring more frequent repairs or replacements, which directly increases operational costs for fishers.

288. (A) Gillnet - Strict physical girth limitation determining enmeshing and wedging
A gillnet selects fish through a physical girth limitation, where the mesh size determines whether a fish is enmeshed or wedged. Fish that are too small swim through the mesh, while fish that are too large cannot penetrate past their operculum, demonstrating the size-selective mechanism of this passive gear.

289. (B) Competing entities from entirely different sectors, such as highly industrialized fleets clashing heavily with small-scale artisanal fishers.
In fisheries, inter-sectoral conflict refers to disputes occurring between entirely different sectors, such as industrial trawlers and small-scale artisanal fishers. These conflicts are driven by competition for shared spatial grounds or resources, where large-scale gears can damage artisanal equipment, disrupt local catches, and spark severe socio-economic tensions.

290. (B) Competing groups of highly similar small-scale fishers fighting heavily over access to the exact same localized reef.
Intra-sectoral conflict occurs within a single fishing sector, such as competing groups of small-scale fishers fighting over access to the same localized reef. These disputes are driven by spatial crowding, gear placement, or localized resource depletion, highlighting the need for community-based rules to manage access and resolve internal tensions.

291. (A) Zonation mapping, legally restricting highly destructive trawlers completely outside designated nearshore depth contours.
To mitigate gear conflicts between industrial trawlers and static artisanal gears, governments implement zonation mapping. This spatial

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214. (B) Allochthonous production
Organic energy inputs originating from terrestrial sources, such as leaves, insects, and woody debris falling into a river, are classified as allochthonous production. In contrast, energy produced within the aquatic system via photosynthesis is termed autochthonous. In headwater streams, allochthonous inputs serve as the primary energy base supporting food webs.

215. (A) The lake is undergoing rapid natural eutrophication and terrestrialization.
When an oxbow lake transitions into a dense swamp dominated by emergent macrophytes, it is undergoing natural eutrophication and terrestrialization. Over time, sediment accumulation and nutrient enrichment shallow the basin, allowing vegetation to colonize the open water. This successional process reduces open-water fish habitats and alters the resident fish community.

216. (D) The massive economic cost of rearing fingerlings, which may suffer intense predation by resident carnivores.
A primary disadvantage of relying on heavy stocking of Indian Major Carps in reservoirs is the high cost of rearing fingerlings, which face intense predation from resident carnivores. If fingerlings are stocked at too small a size, high mortality rates can reduce recapture rates, making the stocking program financially unsustainable.

217. (B) Rational individual actors will exploit the shared resource until economic rent is entirely dissipated and the stock collapses.
In natural resource economics, the Tragedy of the Commons describes how rational individual actors in an open-access fishery will exploit a shared resource until its economic rent is dissipated. Because no one holds property rights, fishers have no incentive to conserve fish for tomorrow, leading to competitive overcapitalization and stock collapse.

218. (A) A state-regulated command-and-control regime.
A fisheries management system where a central government authority dictates mesh sizes, enforces seasonal closures, and restricts licensing is a state-regulated command-and-control regime. This top-down approach relies on formal legal regulations and state enforcement to manage fishing effort, though it can suffer from high monitoring costs and limited stakeholder compliance.

219. (A) Territorial Use Rights for Fishing
In rights-based fisheries management, the acronym TURF stands for Territorial Use Rights for Fishing. This system allocates exclusive harvesting rights within a defined geographic area to a specific community or individual. By restricting access, TURFs aim to eliminate the race for fish, encourage resource stewardship, and support sustainable management.

220. (B) Severe economic rent dissipation, driving fleet profits down to zero.
Allowing unlimited entry into a profitable open-access fishery leads to severe economic rent dissipation. As new vessels enter the fishery, the shared catch is divided among more operators, increasing overall costs without expanding the total yield. This process continues until excess capacity drives net economic profits down to zero.

221. (B) Allocating Individual Transferable Quotas (ITQs) to specific fishers.
Allocating Individual Transferable Quotas to specific fishers is a rights-based catch share management system. Under this framework, the Total Allowable Catch is divided into secure, individual shares that can be caught, sold, or leased. This allocation ends the competitive race for fish, incentivizes long-term resource stewardship, and improves economic efficiency.

222. (A) I, II, III, and IV
The four standard categories of property rights recognized in fisheries economics are open access, state property, communal property, and private property. These regimes define who has the legal right to access, extract, and manage the resource, playing a central role in determining the bioeconomic stability and sustainability of the fishery.

223. (C) Guaranteed free access to highly migratory international tuna fleets
Successful Territorial Use Rights for Fishing rely on clearly defined spatial boundaries, the ability to exclude unauthorized outsiders, and strong local governance. Granting free access to international tuna fleets contradicts these principles, as high seas fleets would disrupt local

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spatial controls, deplete resources, and undermine community-based conservation efforts.

224. (A) Implementing an Individual Transferable Quota (ITQ) system
To incentivize resource stewardship and end the race for fish, managers can implement an Individual Transferable Quota system. By allocating secure, long-term harvest shares to individual fishers, this catch-share program allows them to fish at their own pace. This shift improves vessel safety, stabilizes market pricing, and encourages sustainable harvesting.

225. (D) Open access mathematically guarantees that the fishery operates precisely at Maximum Economic Yield.
The assertion that open access guarantees operation at Maximum Economic Yield is incorrect, as open-access fisheries operate at a bioeconomic equilibrium where economic rent is entirely dissipated. The absence of property rights leads to overcapitalization, where individual fishers lack any rational incentive to conserve resources, driving the stock below sustainable levels.

226. (A) Benthic species are sedentary, while pelagic species migrate outward.
Territorial Use Rights for Fishing are highly effective for managing benthic resources like lobsters because these species are sedentary, remaining within designated spatial boundaries. Conversely, TURFs are difficult to apply to pelagic resources, which migrate across boundaries into open-access areas where local community exclusion rights cannot be enforced.

227. (A) Exclusive, quasi-property harvest rights to a specific proportion of the Total Allowable Catch.
Implementing an Individual Transferable Quota system grants participating fishers exclusive, quasi-property harvest rights to a specific proportion of the Total Allowable Catch. These secure shares do not grant ownership of the ocean itself, but they allow fishers to catch, sell, or lease their portion, encouraging long-term resource stewardship.

228. (A) It leads to quota consolidation, marginalizing small-scale fishers.
A social disadvantage of implementing ITQ systems is the tendency for quota consolidation. Because shares can be traded on the open market, larger, more capitalized corporate operators often buy up quotas from smaller fishers. This consolidation can concentrate ownership, marginalize small-scale fishers, and disrupt the social fabric of coastal communities.

229. (D) Local resource users to possess primary responsibility and authority over the management of local fisheries
Community-Based Fisheries Management empowers local resource users by granting them primary responsibility and authority over managing local resources. This decentralized approach leverages local knowledge, customary laws, and social cohesion to regulate fishing effort. It encourages resource stewardship, improves regulatory compliance, and supports sustainable livelihoods within coastal communities.

230. (A) III, I, IV, II
Co-management structures follow a spectrum of stakeholder participation, starting from top-down government instruction where authorities simply inform users. This is followed by government consultation with communities, joint cooperative management boards where power is shared, and finally, complete community delegation where local resource users hold primary decision-making authority.

231. (A) State/government authorities and local communities/resource users
Co-management is defined as a formal partnership and responsibility-sharing arrangement between state government authorities and local communities or resource users. This collaborative framework successfully blends scientific data with traditional local knowledge, aiming to improve regulatory compliance, resolve resource conflicts, and enhance the overall sustainability of coastal fisheries.

232. (C) Increased local compliance and reduced enforcement costs due to peer pressure.
Decentralizing fisheries management authority to local coastal communities often increases regulatory compliance and reduces government enforcement costs. When local fishers are involved in designing rules, they perceive them as more legitimate. This ownership encourages self-policing and social peer pressure within the community, deterring poaching and illegal fishing.

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233. (A) Traditional/Local Ecological Knowledge (LEK) regarding spawning sites and seasons
A primary asset used in successful Community-Based Fisheries Management is Traditional or Local Ecological Knowledge. This localized understanding of fish behavior, seasonal spawning aggregations, and habitat conditions helps communities design effective conservation measures, such as temporary closed areas, without relying on expensive and data-intensive scientific stock assessments.

234. (D) Strict, unilateral top-down quota imposition by distant central bureaucrats.
Community-Based Fisheries Management is characterized by participatory decision-making, integration of customary laws, and high levels of local social cohesion. Strict, unilateral top-down quota imposition by distant central bureaucrats contradicts this model, as it excludes local input and can lead to community resistance, low regulatory compliance, and resource conflicts.

235. (D) Co-management
Establishing a joint committee of local fisher chiefs and state scientists to resolve gear conflicts is a direct application of co-management. This collaborative partnership shares decision-making power between government regulators and resource users, integrating scientific expertise with local authority to develop effective, mutually accepted spatial rules.

236. (B) The government completely withdraws from all roles, leaving the community isolated without any legal backing.
The statement that the government completely withdraws from all roles in co-management is incorrect. In co-management, the state maintains a supportive role, providing legal backing, scientific data, and conflict-resolution services. This collaborative framework blends science with local knowledge, though establishing trust between parties requires significant time and investment.

237. (A) Unwavering legal recognition and supportive state legislation.
The long-term success of a Community-Based Fisheries Management initiative depends on unwavering legal recognition and supportive state legislation. Without a formal legal framework that empowers communities to exclude outsiders and enforce local rules, local management efforts can be easily undermined by industrial incursions or legal challenges from external fishers.

238. (B) Local stewardship and perceived legitimacy improve regulatory compliance.
Observing a community that actively patrols its own territory and socially shames poachers indicates that local stewardship and perceived legitimacy improve regulatory compliance. When resource users are directly involved in rulemaking, they are more motivated to protect their resources, reducing the need for expensive top-down military enforcement.

239. (A) Transaction costs regarding time, meetings, and negotiation.
A challenge of establishing co-management systems is the initially high transaction costs associated with time, meetings, and negotiations. Building trust, sharing power, and reaching consensus among diverse stakeholders requires significant administrative and social investment. However, these upfront costs can lead to more stable, compliant management over the long term.

240. (C) Co-management - Shared institutional authority and negotiation
Co-management is characterized by shared institutional authority and negotiation between state regulators and local resource users. In contrast, command-and-control regimes rely on centralized top-down rules, while open-access systems lack access controls. Pure community management delegates authority to local groups, relying on social peer pressure and customary rules.

241. (A) The amount, intensity, and type of fishing effort deployed
In fisheries regulation, input controls are management measures that restrict the amount, intensity, and type of fishing effort deployed. These controls include limiting the number of licenses, capping vessel size and engine horsepower, restricting fishing days, or limiting the size and quantity of fishing gear used in the fishery.

242. (B) Restrict the total number of vessels or fishers legally participating in a fishery
A limited entry scheme is an input control designed to restrict the total number of vessels or fishers legally participating in a fishery. By

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small-scale operators and alter traditional fishing communities.

263. (B) It favors efficiency and privatization over historic community equity.
A social criticism of Individual Transferable Quota systems is that they prioritize economic efficiency and privatization over historic community equity. By treating harvest rights as private property, ITQs can lead to rapid quota consolidation, reducing the number of local fishers and shifting economic benefits away from traditional coastal communities.

264. (A) Output control: Individual Transferable Quota | Input control: Freezing the total number of issued licenses
This pair correctly contrasts an output control with an input control. An Individual Transferable Quota is an output control that regulates the total weight of fish harvested. Conversely, freezing the number of issued licenses is an input control that directly restricts the number of participants, illustrating the different regulatory mechanisms used.

265. (A) All forms of extractive fishing activities are strictly prohibited.
No-take zones are marine areas where all forms of extractive fishing activities are strictly prohibited. These spatial closures are established to protect critical spawning habitats, restore local biodiversity, and allow depleted fish populations to recover without targeted fishing mortality, supporting the long-term resilience of the wider marine ecosystem.

266. (B) Protect highly vulnerable biological life stages, such as dense spawning aggregations or peak recruitment periods.
Enforcing closed seasons is a temporal management tool designed to protect vulnerable biological life stages, such as dense spawning aggregations or peak recruitment periods. By prohibiting fishing during these critical windows, this regulation reduces mortality on breeding adults and recruits, supporting population replenishment and the productivity of the fishery.

267. (A) The Spillover Effect
The spillover effect describes the biological emigration of adult and juvenile fish from within a Marine Protected Area across its boundaries into adjacent fished waters. As biomass builds up inside the no-take zone, density-dependent pressure drives fish to migrate outward, helping replenish surrounding fisheries and supporting local catches.

268. (A) High protection of mature broodstock from targeted fishing mortality during reproduction
Establishing a no-take Marine Protected Area over a grouper spawning site provides high protection for mature broodstock from targeted fishing mortality during their reproductive phase. Protecting these spawning aggregations ensures successful fertilization and larval production, which can disperse via ocean currents to replenish fish stocks in surrounding fished areas.

269. (A) Minimum Legal Size (MLS)
A Minimum Legal Size regulation mandates that all captured individuals below a specified physical length must be returned to the water. This technical control aims to protect juvenile fish from harvest, ensuring they survive to reach sexual maturity and reproduce at least once before they can be legally retained.

270. (D) Mandatory implementation of pure Individual Transferable Quotas (ITQs)
Spatial and temporal controls include rotating closures, permanent no-take marine reserves, and seasonal fishing bans. Conversely, Individual Transferable Quotas are catch-share regulations classified as output controls. While ITQs directly regulate harvest weights, they do not restrict where or when fishing occurs, unless paired with spatial-temporal regulations.

271. (A) An ecologically connected MPA network promoting larval dispersal
Spacing multiple smaller Marine Protected Areas along a coastline connected by ocean currents creates an ecologically connected MPA network. This spatial design facilitates larval dispersal and juvenile movement between reserves, enhancing regional population persistence and directly helping replenish adjacent fished areas through the export of recruits.

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272. (C) MPAs are universally the single most effective tool for managing highly migratory oceanic tunas.
While Marine Protected Areas protect sedentary benthic species and complex habitats, they are not the most effective tool for managing highly migratory species like oceanic tunas. Tunas travel

dimensions. Correctly pairing management tools with their regulatory mechanisms is essential for designing effective conservation policies.

253. (A) Total Allowable Catch
In fisheries management, the acronym TAC stands for Total Allowable Catch. This output control sets a maximum limit on the total physical weight of a fish stock that can be legally harvested during a specific time period, aiming to keep fishing mortality within sustainable biological limits.

254. (B) Privately held, market-tradable rights to a defined proportion of the harvest.
Individual Transferable Quotas transform a shared public resource into privately held, market-tradable rights to a defined proportion of the harvest. By allocating specific shares of the Total Allowable Catch to individual fishers, this system aims to eliminate the race for fish and encourage long-term stewardship of the resource.

255. (D) Conducting rigorous, up-to-date scientific stock assessments to estimate current biomass
Setting a sustainable Total Allowable Catch requires conducting rigorous, up-to-date scientific stock assessments to estimate current biomass. These assessments use catch, effort, and age data to model population dynamics, allowing managers to set catch limits that prevent overfishing and support the long-term reproductive capacity of the stock.

256. (B) High-grading
When operating under strict weight limits, fishers may engage in high-grading, which involves discarding lower-value fish to save quota space for higher-value individuals. This practice allows operators to maximize their profits under a quota but leads to unrecorded discard mortality, which can compromise the accuracy of stock assessments.

257. (C) It promotes economic efficiency by allowing less efficient operators to sell quota and exit the fishery.
The transferability aspect of an ITQ system promotes economic efficiency by allowing less efficient operators to sell or lease their quotas to more efficient fishers and exit the industry. This market mechanism reduces overall fleet capacity, lowers operational costs, and consolidates harvesting power without exceeding the Total Allowable Catch.

258. (C) Restricting the maximum allowable engine horsepower
Output controls directly regulate catch limits, including competitive Total Allowable Catches, vessel trip limits, and individual transferable quotas. Conversely, restricting engine horsepower is an input control that limits the physical power of the vessel. Differentiating between input and output controls is critical for understanding the bioeconomic drivers of a fishery.

259. (A) Biologically determined Total Allowable Catch
When a scientific council models target fishing mortality against current biomass to set a harvest limit in tons, it is establishing a biologically determined Total Allowable Catch. This output limit directly aims to prevent overexploitation by keeping catch levels aligned with the stock's biological productivity and replenishment rate.

260. (D) They completely and inherently eliminate all bycatch and ecological damage.
The statement that competitive Total Allowable Catches eliminate bycatch and ecological damage is incorrect. Competitive TACs often trigger a race for fish, where operators use non-selective gear to harvest as fast as possible before the overall limit is reached. This race increases gear conflicts, market gluts, and bycatch issues.

261. (A) It ends the "race for fish," improving safety and spreading landings.
The primary socioeconomic justification for transitioning to an Individual Transferable Quota system is that it ends the race for fish. By allocating secure catch shares, ITQs allow fishers to choose when to fish based on weather and market conditions, improving vessel safety and stabilizing market supplies throughout the year.

262. (C) Consolidate into the hands of a few large corporate operators.
In established Individual Transferable Quota markets, quotas often consolidate into the hands of a few large corporate operators. Because shares are tradeable, larger entities with greater capital can purchase quotas from smaller fishers. Flowing from this tradeability, consolidation improves economic efficiency but can marginalize

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freezing the issuance of new commercial licenses, this regulation directly aims to prevent expansion of fishing capacity and reduce competitive exploitation in the fishery.

243. (A) Vessel hull length, gross tonnage, and engine horsepower
To regulate total vessel capacity, authorities restrict structural parameters, including vessel hull length, gross tonnage, and engine horsepower. These limits control the overall harvesting power of individual vessels, preventing them from carrying more gear or operating in offshore waters that are closed to smaller, traditional fleets.

244. (B) Capital stuffing (effort creep)
Restricting fishing days often incentivizes fishers to invest in technological upgrades to maximize their daily catch rates. This behavioral response is termed capital stuffing or effort creep. By upgrading engines, sonar, or gear selectivity, fishers expand their harvesting power, which can undermine the conservation goals of input regulations.

245. (C) Restricting vessels to fishing only 15 days per calendar month
Restricting vessels to fishing only fifteen days per calendar month is an effort-based input control. By capping the total allowable fishing time, this regulation directly aims to reduce overall fishing mortality. However, it can incentivize fishers to fish harder during open days, a response known as effort concentration.

246. (D) Establishing Individual Transferable Quotas (ITQs)
Input controls include restricting engine horsepower, capping the number of traps per vessel, and freezing commercial fishing licenses. Conversely, Individual Transferable Quotas are classified as output controls. Instead of restricting fishing effort, ITQs directly regulate the total physical weight of fish that can be harvested from the stock.

247. (A) The physical towing speed and gross sweeping area of trawl nets.
Restricting vessel engines to a maximum of one hundred horsepower is an input control that directly limits towing speed and the sweeping area of trawl nets. Capping engine power reduces the rate at which nets are dragged, limiting catch efficiency and helping protect benthic habitats from excessive sweeping.

248. (A) Input controls directly guarantee a precise, biologically exact total catch weight.
The statement that input controls guarantee a precise total catch weight is incorrect. Because of changes in fish catchability and technological upgrades, restricting effort does not guarantee a precise catch volume. Fishers often circumvent these controls by optimizing unregulated inputs, meaning a license freeze alone cannot stop capacity expansion.

249. (B) The insidious increase in true fishing power due to technological advances (e.g., better sonar), despite nominal controls.
Effort creep is the gradual increase in the true harvesting power of a fleet due to technological advancements, such as high-resolution sonar, GPS mapping, or improved gear efficiency. This increase occurs even when nominal input controls, like license limits, remain unchanged, allowing fleets to locate and capture fish more efficiently.

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250. (C) Substitute unregulated technical inputs for regulated inputs to maintain rates.
From the widespread occurrence of capital stuffing, economists can infer that fishers will substitute unregulated technical inputs for regulated ones to maintain their catch rates. When managers restrict one input, like vessel length, fishers may increase engine power or adopt better fish-finding technologies, maintaining their overall harvesting capacity.

251. (C) They are relatively straightforward to visually monitor and structurally enforce at port.
An advantage of using input controls in data-poor fisheries is that they are straightforward to monitor and enforce at port. Checking vessel licenses, measuring mesh sizes, and counting traps does not require real-time catch monitoring or extensive biological data, making these controls practical for agencies with limited resources.

252. (B) License Limitation - Capping the maximum total number of participating operators
A license limitation scheme is an input control designed to cap the maximum number of participating operators in a fishery. In contrast, Individual Transferable Quotas are output controls, while minimum legal sizes regulate fish

vast distances far beyond MPA boundaries, meaning their conservation requires regional cooperation and catch limits rather than static spatial closures.

273. (A) It exports larvae to replenish fished stocks in surrounding areas.
A primary benefit of a successful, virtual no-take zone is that it exports larvae to replenish fished stocks in surrounding areas. As mature fish build up inside the reserve, their reproductive output increases, and ocean currents disperse their larvae across boundaries, supporting recruitment in adjacent, heavily fished zones.

274. (A) Massive effort displacement will heavily concentrate the entire fleet into the remaining 70%, potentially causing localized overfishing.
Closing thirty percent of coastal waters without reducing fleet capacity causes effort displacement. The entire fishing fleet concentrates its harvesting power into the remaining seventy percent of open waters. This compression can increase localized fishing mortality, accelerate gear conflicts, and deplete resources in open areas, offsetting the benefits of the spatial closure.

275. (B) Deficiencies in funding, surveillance, and enforcement against poaching.
A major operational challenge limiting the effectiveness of Marine Protected Areas in developing nations is the lack of funding, surveillance, and enforcement resources. Without regular patrols, spatial closures can become 'paper parks' that exist on paper but fail to prevent poaching, directly undermining the conservation benefits of the reserve.

276. (A) Spatial: Establishing a fixed no-take coral reef reserve | Temporal: Implementing a strict two-month monsoon fishing ban
This pair correctly contrasts a spatial management tool with a temporal one. Establishing a permanent no-take coral reef reserve restricts fishing activities geographically. Conversely, implementing a strict two-month monsoon fishing ban restricts fishing temporally during a specific season, demonstrating the different dimensions of fisheries management.

277. (A) Fishing effort and gear selectivity (age/size at first capture) are perfectly optimized together to mathematically maximize the yield per recruit.
In fisheries science, eumetric fishing describes a management regime where fishing effort and gear selectivity are optimized together to maximize the yield per recruit. By adjusting mesh sizes to delay the age at first capture, this strategy ensures that fish are harvested at their optimal growth weight, maximizing fleet output.

278. (B) Selectivity ogive
A selectivity ogive is a S-shaped mathematical curve representing the probability that a fish of a specific length will be retained by a fishing gear. This curve shows how catch retention increases with fish size, helping managers determine the length at fifty percent retention to assess size-selectivity.

279. (D) Undersized, sexually immature juvenile fish can completely escape and survive to spawn at least once.
Optimizing trawl codend mesh sizes is implemented to ensure that undersized, sexually immature juvenile fish can escape through the meshes. Allowing juveniles to escape and reach sexual maturity before capture directly supports population replenishment, prevents growth overfishing, and helps maintain the reproductive capacity of the stock.

280. (A) Initial drop in catch, followed by long-term increase in yield.
Increasing mesh size to shift the length at fifty percent retention to the right causes an initial drop in catch, as smaller fish escape. However, as these escaped individuals survive and grow to larger sizes, the long-term yield of the fishery increases, demonstrating the benefits of size-selective harvesting.

281. (A) Installing rigid separator grids or strategically placed acoustic pingers on nets
Active gear modifications, such as installing rigid separator grids or acoustic pingers, are designed to alter species selectivity. Separator grids allow target species to pass into the codend while directing non-target species out of the net, and acoustic pingers deter marine mammals, reducing incidental bycatch and discard mortality.

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204. (C) It masks the underlying causes of wild stock decline, such as severe habitat degradation or overfishing.
A biological disadvantage of relying on continual stocking to maintain a fishery is that it can mask the underlying causes of wild stock declines, such as habitat degradation, pollution, or overfishing. By artificially maintaining catch rates, stocking can reduce the incentive to implement necessary habitat restoration or harvest regulations.

205. (A) Highly productive ecotones functioning as crucial nursery and feeding grounds
Floodplain wetlands, known as beels or maans in India, are highly productive ecotones that connect terrestrial and aquatic environments. They function as crucial nursery, spawning, and feeding grounds for many freshwater fish species. These dynamic habitats rely on seasonal flood pulses to exchange nutrients, organic matter, and biological organisms with rivers.

206. (D) Lentic
In freshwater ecology, flowing-water ecosystems like rivers and streams are classified as lotic, whereas standing-water environments such as lakes, ponds, and reservoirs are termed lentic. Distinguishing between these two habitat types is fundamental, as they support distinct biological communities, nutrient cycling processes, and fisheries management approaches.

207. (C) The initial trophic upsurge following inundation, which gradually declines as flooded nutrients are exhausted.
A key factor governing reservoir productivity is the trophic upsurge phase that occurs after initial inundation. Flooding terrestrial vegetation releases nutrients, driving a temporary increase in primary productivity and fish growth. Over time, these nutrients are depleted or buried in sediment, and reservoir productivity gradually declines to a lower equilibrium level.

208. (C) Exposure and desiccation of shallow littoral spawning grounds and benthic fauna.
Severe seasonal drawdown in reservoirs can expose and desiccate shallow littoral zones. These areas serve as critical spawning grounds and benthic habitats for many fish species. Rapid water level fluctuations disrupt egg development, increase juvenile mortality, and deplete benthic food resources, impacting the reproductive success and productivity of reservoir fisheries.

209. (A) The Flood Pulse Concept
The Flood Pulse Concept is the primary ecological framework explaining high fish productivity in river-floodplain systems. It states that the seasonal rise and fall of river water laterally inundates adjacent floodplains, driving nutrient exchange and biological productivity. This lateral connectivity provides fish with temporary access to rich feeding and spawning habitats.

210. (B) P-2, Q-3, R-4, S-1
Hydrological water bodies possess distinct ecological characteristics. Riverine fisheries rely on longitudinal connectivity and flowing lotic waters, while artificial reservoirs are impacted by severe seasonal drawdowns. Floodplain wetlands depend on lateral connectivity and seasonal flooding, while estuarine fisheries are shaped by tidal flushing and fluctuating salinity gradients.

211. (D) Severe isolation from all freshwater riverine inputs.
Healthy estuarine fisheries are defined by high nutrient trapping, tidal flushing, and salinity gradients, functioning as critical nurseries for euryhaline marine species. They are not isolated from freshwater inputs; instead, estuaries depend on freshwater river discharge to maintain their brackish conditions and nutrient supplies, supporting high biological productivity.

212. (B) Enhance phytoplankton production and create navigable space for fishing gear.
Clearing excessive submerged macrophytes from a weed-choked oxbow lake is done to enhance phytoplankton production and create navigable space for fishing gear. While moderate vegetation provides habitat, excessive weeds block sunlight, deplete dissolved oxygen, and restrict gear deployment. Managing weed density helps restore ecological balance and improves harvest efficiency.

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213. (D) Fish productivity in reservoirs is uniform and static across all decades of its existence.
The assertion that reservoir productivity is uniform and static over time is incorrect, as reservoirs go through distinct trophic phases, including an initial upsurge followed by a decline. Productivity varies based on depth and shoreline development, and stocking is often used to occupy new pelagic niches, while dams block migrations.

regulation restricts trawlers from operating within nearshore depth contours, legally reserving shallow coastal waters for small-scale fishers. This separation prevents gear damage, protects sensitive nursery habitats, and reduces social conflicts.

292. (C) Severe immediate destruction of deployed artisanal gears and highly depressed local landings, sparking violent protests.
Unregulated nearshore incursions by industrial bottom trawlers can cause severe economic impacts on artisanal communities. Trawl gears can destroy static artisanal equipment like gillnets and traps, while intensive harvesting depletes nearshore resources. This loss of gear and catch reduces local incomes, threatening food security and sparking social protests.

293. (A) Facilitating and heavily financing viable alternative livelihood options outside the capture fishery.
Addressing fisher poverty and reducing overall fishing effort can be achieved by facilitating and financing viable alternative livelihood options outside the capture fishery. Providing secondary incomes in sectors like coastal aquaculture, ecotourism, or post-harvest processing reduces financial dependence on declining wild stocks, directly supporting sustainable transitions.

294. (B) Transitioning to heavily unregulated, destructive coastal sand mining
Sustainable alternative livelihoods include mariculture, eco-tourism, and post-harvest value addition, which utilize maritime skills without expanding fishing pressure. Conversely, transitioning to unregulated coastal sand mining is highly unsustainable. It degrades coastal habitats, alters beach morphology, and damages the marine environment, directly undermining the goals of fisheries conservation.

295. (A) Non-extractive alternative livelihoods (ecotourism) to offset extreme fishing pressure
Pivoting from commercial harvesting to guiding tourists through recovered coral reefs is a practical application of leveraging non-extractive alternative livelihoods to offset fishing pressure. This transition generates sustainable income from conservation, encouraging resource stewardship and allowing depleted marine populations to recover, while supporting the local economy.

296. (C) Simply providing generic secondary incomes automatically perfectly reduces strictly all primary fishing effort unconditionally.
The assumption that generic secondary incomes automatically reduce fishing effort is incorrect. Fishers may use supplementary income to upgrade their vessels, expanding fishing power. Transitioning fishers out of the industry requires capital, re-skilling, and addressing cultural attachments to fishing, while market access determines the success of new livelihoods.

297. (A) Participatory co-management platforms fostering dialogue and compromise.
The most effective foundational mechanism for resolving entrenched inter-sectoral fisheries conflicts is establishing participatory co-management platforms. These cooperative forums bring together industrial, artisanal, and scientific stakeholders to negotiate spatial rules, share responsibility, and develop mutually accepted agreements, improving compliance and reducing tensions.

298. (A) Local economic hardship, debt, and subsequent poaching will skyrocket.
Implementing seasonal closures on impoverished fleets without mitigation can cause economic hardship, debt, and increased poaching. Because fishers lack financial reserves or alternative incomes, prohibiting fishing deprives them of livelihoods. Without compensation or food security support, regulatory compliance declines, and illegal harvesting increases to meet basic needs.

299. (A) It can strategically leverage existing maritime skills and provide desperately needed stable supplementary income.
Promoting integrated coastal mariculture as an alternative to capture fisheries allows communities to leverage their existing maritime skills, such as boat handling and species knowledge. This transition provides a stable secondary income, reducing fishing pressure on wild stocks and supporting coastal livelihoods without requiring a complete shift to terrestrial work.

300. (C) Conflict: Trawlers destroying local artisanal crab traps | Mitigation: Strictly designating exclusive shallow-water non-trawling zones.
This pair correctly links a gear conflict with its spatial mitigation strategy. When industrial trawlers destroy static artisanal traps, managers

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2010
78. Which of the following pollutants is classic for undergoing severe biomagnification in aquatic food webs?
(A) Methylmercury
(B) Nitrate
(C) Ascorbic acid
(D) Ethanol

2015
79. The dynamic model of bioaccumulation estimates the net internal concentration of a toxicant based on the balance between:
(A) Respiration rate and heart rate
(B) Water temperature and oxygen
(C) Predator and natural mortality
(D) Uptake and elimination rates

2011
80. Identify the INCORRECT pair regarding toxicant pathways:
(A) BCF - Uptake only from water
(B) BAF - Uptake from all environmental sources
(C) BMF - Transfer across consecutive trophic levels
(D) $K_{\{ow\}}$ - Measure of chemical toxicity to enzymes

2010
81. How does "growth dilution" affect the internal concentration of a bioaccumulated toxicant in a fish?
(A) Increases levels during growth
(B) Decreases concentration via volume expansion
(C) Enhances chemical toxicity directly
(D) Halts internal elimination processes

2004
82. For a lipophilic organic pollutant, organisms with higher lipid content will generally exhibit:
(A) Higher bioaccumulation factors
(B) Lower bioaccumulation factors
(C) Complete immunity to the pollutant
(D) Zero biomagnification

2006
83. The toxic equivalent (TEQ) approach is primarily applied to assess mixtures of which biomagnifying compounds?
(A) Heavy metals
(B) Organophosphate insecticides
(C) Microplastics
(D) Dioxins and dioxin-like PCBs

2009
84. Which mechanism facilitates the transformation of inorganic mercury to highly bioavailable methylmercury in aquatic sediments?
(A) Photolysis by UV radiation
(B) Anaerobic bacterial methylation activity
(C) Chemical oxidation in oxygenated water
(D) Phytoplankton respiration processes

2015
85. Ecological resilience is defined as:
(A) Resistance to structural change
(B) Disturbance magnitude before state shift
(C) Speed of primary succession rates
(D) Permanent loss of key species

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2024
86. Ecological homeostasis in aquatic environments refers to:
(A) Unchecked exponential population growth
(B) Complete absence of fluctuations
(C) Internal stability despite external changes
(D) Exclusion of invasive populations

2006
87. A disturbed aquatic ecosystem that rapidly returns to its pre-disturbance state exhibits high:
(A) Engineering resilience (stability)
(B) Hysteresis
(C) Eutrophication
(D) Biomagnification

2019
88. The concept of "alternative stable states" implies that:
(A) Only one climax community exists
(B) Systems always revert to origin
(C) Aquatic stability is impossible
(D) Disturbance causes persistent structural shifts

2011
89. A shallow lake shifting from a clear-water macrophyte-dominated state to a turbid phytoplankton-dominated state is a classic example of:
(A) Biomagnification
(B) A catastrophic regime shift
(C) Engineering resilience
(D) Primary succession

2001
90. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): High biodiversity generally enhances the ecological resilience of an aquatic

CHAPTER 06

Aquatic Ecosystem and Restoration

2002

1. Which of the following defines the profundal zone of a lentic ecosystem?
(A) Deep-water zone below effective light penetration
(B) Shallow-shore zone with full-bottom light penetration
(C) Open-surface zone with maximal primary production
(D) Coastal-marine zone within estuarine environments

2021

2. In lotic ecosystems, the continuous downstream gradient of physical conditions and corresponding biological communities is best described by which concept?
(A) Competitive exclusion principle
(B) Intermediate disturbance hypothesis
(C) River continuum concept
(D) Ecotone transition theory

2008

3. Which physico-chemical parameter typically exhibits the most significant vertical stratification in estuaries?
(A) Salinity
(B) Dissolved oxygen
(C) Turbidity
(D) Alkalinity

2024

4. Identify the INCORRECT statement regarding the neritic zone of marine ecosystems.
(A) It is situated above the continental shelf
(B) It generally exhibits high primary productivity
(C) It is characterized by relatively stable salinity compared to estuaries
(D) It lacks sufficient sunlight for photosynthesis

2016

5. The transition layer in a lake where temperature decreases rapidly with increasing depth is known as the:
(A) Epilimnion
(B) Thermocline
(C) Hypolimnion
(D) Halocline

2004

6. A positive estuary is best characterized by which of the following conditions?
(A) Evaporation exceeds inflow, causing hypersalinity
(B) Tidal mixing removes all vertical stratification
(C) Freshwater inflow exceeds evaporation rates
(D) Salinity remains zero throughout the system

2023

7. The primary force driving the spatial zonation of benthic organisms in rocky intertidal shores is:
(A) Predation pressure exclusively
(B) Nutrient availability from upwelling
(C) Salinity fluctuations during rainfall
(D) Desiccation tolerance during low tides

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2005

8. In marine ecosystems, the aphotic zone begins approximately at what depth, marking the cessation of effective photosynthesis?
(A) 50 meters
(B) 200 meters
(C) 1000 meters
(D) 4000 meters

2021

9. Which habitat exhibits the highest spatial and temporal variability in physico-chemical properties?
(A) Abyssal marine zones
(B) Estuarine ecosystems
(C) Profundal lentic zones
(D) Tropical open oceans

2017

10. Consider the following statements about lotic ecosystems:
I. Velocity of flow decreases continuously from headwaters to mouth.
II. Riparian vegetation contributes significantly to allochthonous energy inputs.
III. Turbidity generally decreases downstream as sediments settle.
Which of the above statement(s) is/are correct?

(A) I and II
(B) II and III
(C) I and III
(D) I, II, and III

2018
11. The lotic environment is primarily distinguished from the lentic environment by which predominant feature?
(A) Unidirectional continuous water flow
(B) Thermal stratification
(C) Absence of phytoplankton
(D) Higher salinity levels

2012
12. Marine snow plays a crucial role in which of the following ecological processes?
(A) Increasing surface albedo in polar oceans
(B) Forming ice habitats for Arctic mammals
(C) Vertical organic matter transport to benthos
(D) Driving global thermohaline circulation

2023
13. Gross Primary Productivity (GPP) in an aquatic ecosystem is defined as:
(A) Net organic carbon available to consumers
(B) Biomass generation rate of secondary levels
(C) Detrital biomass accumulation over time
(D) Total autotrophic organic carbon production

2015
14. Which method is most sensitive for measuring primary productivity in oligotrophic aquatic habitats?
(A) Light and dark bottle dissolved oxygen method
(B) Secchi disk measurement
(C) Carbon-14 (^{14}C) radiotracer technique
(D) Chlorophyll fluorescence

2005
15. In the light and dark bottle method, the oxygen concentration in the dark bottle after a specific incubation period represents:
(A) Net primary productivity
(B) Community respiration
(C) Gross primary productivity
(D) Phytoplankton biomass

2021
16. The carrying capacity of an aquatic habitat is mathematically defined as:
(A) Minimum population size for local survival
(B) Intrinsic fish species growth rate values
(C) Maximum sustainable environmental population
(D) Instantaneous mortality from resistance

2024
17. Secondary productivity in an aquatic ecosystem refers to the rate of biomass formation by:
(A) Benthic macroalgae
(B) Phytoplankton
(C) Chemosynthetic bacteria
(D) Heterotrophs

2008
18. An aquatic ecosystem is observed to have a GPP of $100 gCm^{-2}yr^{-1}$ and autotrophic respiration of $40 gCm^{-2}yr^{-1}$. The Net Primary Productivity (NPP) is:
(A) $140 gCm^{-2}yr^{-1}$
(B) $60 gCm^{-2}yr^{-1}$
(C) $2.5 gCm^{-2}yr^{-1}$
(D) $4000 gCm^{-2}yr^{-1}$

2002
19. Identify the INCORRECT statement regarding the carbon-14 technique for primary productivity measurement.
(A) It involves incubating water samples with a known amount of $NaH^{\{14\}}CO_3$
(B) It predominantly measures net primary productivity over long incubations
(C) It is less sensitive than the oxygen evolution method
(D) It requires filtration of the sample post-incubation

2021
20. Consider the following statements regarding primary productivity:
I. Light penetration is the sole limiting factor in marine ecosystems.
II. Estuaries typically have higher NPP than open oceans.
III. Carrying capacity estimations rely exclusively on primary production data.
IV. Nutrient upwelling enhances localized primary productivity.
Which of the above statement(s) is/are correct?
(A) I and III
(B) II and IV
(C) I, II, and III
(D) II, III, and IV

2009
21. Which limitation is primarily associated with the traditional light and dark bottle oxygen technique?
(A) Requirement of expensive radioactive

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isotopes
(B) Insufficient sensitivity for eutrophic waters
(C) Measurement of strictly heterotrophic respiration
(D) Error from microbial respiration overestimation

2001
22. In the context of carrying capacity estimation, Liebig's Law of the Minimum states that:
(A) Growth is dictated by total resources available
(B) Growth is limited by the scarcest resource
(C) Small populations have higher growth rates
(D) Capacity is invariant to nutrient flux

2004
23. An increase in the biological oxygen demand (BOD) of a water body typically indicates:
(A) Decreased heterotrophic activity
(B) A transition from a eutrophic to an oligotrophic state
(C) Increased organic loading and secondary productivity
(D) Elevated gross primary production exclusively

2003
24. What is the most significant constraint on secondary productivity in deep-ocean benthic ecosystems?
(A) Low dissolved oxygen
(B) Extreme hydrostatic pressure
(C) Absence of necessary breeding substrates
(D) Limited influx of particulate organic matter

2025
25. According to Lindeman's 10% rule, if the primary producers synthesize $10{,}000 \frac{kcal}{m^2}$, the energy available to secondary consumers is approximately:
(A) $1{,}000 \frac{kcal}{m^2}$
(B) $100 \frac{kcal}{m^2}$
(C) $10 \frac{kcal}{m^2}$
(D) $1 \frac{kcal}{m^2}$

2013
26. In trophodynamics, assimilation efficiency is defined as:
(A) Ratio of energy ingested to total available
(B) Percent of ingested energy absorbed by gut
(C) Percent of energy converted to new biomass
(D) Ratio of secondary to primary production

2011
27. Why are ecological pyramids of biomass frequently inverted in aquatic ecosystems?
(A) Inefficient zooplankton energy consumption
(B) Lower weight of benthic versus pelagic organisms
(C) High phytoplankton turnover supporting biomass
(D) Lack of carbon structures in primary producers

2010
28. Which of the following best describes a detritus food web in an aquatic ecosystem?
(A) Begins with living photoautotrophs and grazers
(B) Relies entirely on deep chemosynthetic bacteria
(C) Exists independent of primary producer inputs
(D) Originates from microbial processing of matter

2008
29. Trophic cascades in aquatic food webs are predominantly examples of:
(A) Top-down control
(B) Bottom-up control
(C) Lateral nutrient fluxes
(D) Thermodynamic equilibrium

2011
30. Consider the following statements regarding energy transfer:
I. Ecological efficiency generally limits aquatic food chains to 4-5 trophic levels.
II. Energy flow through an ecosystem is unidirectional.
III. The pyramid of energy can occasionally be inverted.
IV. Omnivory complicates the assignment of discrete trophic levels.
V. Respiration losses decrease at higher trophic levels.
Which of the above statement(s) is/are INCORRECT?
(A) I and II
(B) III and V
(C) II, III, and IV
(D) I, IV, and V

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can establish exclusive shallow-water non-trawling zones. Legally separating the active towed gear from the static gear prevents physical damage, protects nearshore nursery habitats, and reduces social tensions.

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(D) Bioaccumulation of heavy metals

2025

43. Which index is commonly used to quantify the trophic level of a consumer based on stable isotope analysis?
(A) Carbon-14 (^{14}C) decay
(B) Phosphorus-32 (^{32}P) assimilation
(C) Oxygen-18 ($\delta^{18}O$) fractionation
(D) Nitrogen-15 ($\delta^{15}N$) enrichment

2017

44. Character displacement is an evolutionary consequence of:
(A) Commensalism
(B) Intraspecific cooperation
(C) Interspecific competition
(D) Allopatric speciation

2024

45. A keystone species impacts its ecological community primarily by:
(A) Serving as the primary autotroph
(B) Exerting high influence relative to abundance
(C) Possessing the highest overall biomass
(D) Occupying the lowest trophic level

2002

46. An organism that shifts its diet from zooplankton to smaller fishes as it matures is exhibiting:
(A) Competitive exclusion
(B) Ontogenetic niche shift
(C) Trophic downgrading
(D) Neutralism

2012

47. Which term describes the phenomenon where two species evolve in response to each other's competitive pressures over time?
(A) Commensalism
(B) Amensalism
(C) Biomagnification
(D) Coevolution

2005

48. Identify the INCORRECT statement regarding trophic indices.
(A) They provide a fractional value indicating an organism's position in a food web
(B) Primary producers are strictly assigned a trophic index of zero
(C) Omnivory results in non-integer trophic level values
(D) They can be calculated using gut content analysis

2016

49. Which of the following organisms is classified as meroplankton?
(A) Permanent planktonic diatom life cycles
(B) Benthic crab larvae settling after maturation
(C) Copepods undergoing vertical migration
(D) Permanent abyssal zone foraminifera

2009

50. Match the aquatic functional group (List-I) with its correct definition (List-II).
List I: (Functional Group)
P. Neuston
Q. Nekton
R. Periphyton
S. Benthos
List II: (Definition)
1. Organisms attached to submerged surfaces
2. Organisms living on or in the bottom sediments
3. Organisms living at the air-water interface
4. Organisms capable of swimming against water currents
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-1, Q-2, R-3, S-4
(D) P-3, Q-1, R-4, S-2

2025

51. Phytoplankton are integral to aquatic biogeochemical cycles because they are responsible for:
(A) Sequestration of carbon via the biological pump
(B) Deep ocean nitrogen fixation exclusively
(C) Methane production in anaerobic sediments
(D) Decomposition of dissolved organic matter

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2011

52. Holoplankton differ from meroplankton in that holoplankton:
(A) Spend only their larval stage in the pelagic zone
(B) Remain planktonic for their entire life cycle
(C) Are exclusively heterotrophic
(D) Are strictly benthic during reproduction

2017

53. The classification of benthos based on size includes all the following EXCEPT:
(A) Microbenthos
(B) Meiobenthos
(C) Megaplankton
(D) Macrobenthos

2013

31. The primary cause of low ecological transfer efficiency between trophic levels is:
(A) Complete assimilation of consumed biomass
(B) Overpredation by apex predators
(C) Absence of detritivores in the food web
(D) Incomplete digestion and metabolic heat loss

2021

32. In a classic aquatic food chain consisting of Phytoplankton $\rightarrow$ Zooplankton $\rightarrow$ Planktivorous fish $\rightarrow$ Piscivorous fish, the piscivorous fish occupies which trophic level?
(A) First trophic level
(B) Second trophic level
(C) Third trophic level
(D) Fourth trophic level

2009

33. Which parameter is used to quantify the flow of energy between adjacent trophic levels?
(A) Ecological transfer efficiency
(B) Consumption efficiency
(C) Production efficiency
(D) Biomagnification factor

2017

34. Identify the correct pair representing an aquatic primary producer and its typical consumer.
(A) Cyanobacteria - Piscivorous fish
(B) Kelp - Phytoplankton
(C) Diatoms - Copepods
(D) Benthic amphipods - Dinoflagellates

2014

35. What is the fundamental distinction between a food chain and a food web?
(A) Inclusion of detritivores in chains only
(B) Unidirectional nutrient cycling in chains
(C) Restriction to three trophic levels in webs
(D) Interconnected nature of multiple food chains

2002

36. High production efficiency in aquatic invertebrates relative to vertebrates is primarily attributed to:
(A) Their higher rates of locomotion
(B) Their lack of thermoregulation costs (ectothermy)
(C) Their exclusive reliance on detritus
(D) Their longer lifespans

2004

37. The fundamental niche of a species is defined as:
(A) Role within restricted trophic levels
(B) Distribution after predation pressure
(C) Physical space with competitors present
(D) Full range of survivable environmental conditions

2016

38. Gause's principle of competitive exclusion states that:
(A) Species with niche overlap coexist indefinitely
(B) Species sharing a limiting resource cannot coexist
(C) Predation prevents any single niche dominance
(D) Partitioning leads to subordinate extinction

2018

39. Mathematical modeling of a trophic index in aquatic ecosystems primarily utilizes data concerning:
(A) Dietary composition and prey trophic levels
(B) Genetic diversity among apex predators
(C) Ratio of detritus to total live biomass
(D) Total volume of the monitored water body

2002

40. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The realized niche of a species is generally smaller than its fundamental niche.
Reason (R): Interspecific competition and predation restrict the environmental conditions a species can actually exploit.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2014

41. Resource partitioning allows sympatric species to avoid competitive exclusion by:
(A) Interbreeding to form hybrid species
(B) Utilizing different resources or habitats within the same ecosystem
(C) Eliminating the limiting resource completely
(D) Migrating to entirely different biogeographic realms

2021

42. In ecological modeling, the Lotka-Volterra equations are classically used to model:
(A) Ocean current trajectories
(B) Primary productivity gradients
(C) Predator-prey dynamics and interspecific competition

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2018
66. Which organism is commonly used as a bioindicator for fecal contamination in aquatic habitats?
(A) Escherichia coli
(B) Daphnia magna
(C) Lemna minor
(D) Salmo trutta

2003
67. Which index evaluates biological integrity by comparing the species composition of a site to a reference unimpacted site?
(A) Hilsenhoff Biotic Index
(B) Index of Biological Integrity (IBI)
(C) Shannon-Wiener Index
(D) Simpson's Diversity Index

2015
68. Biomarkers in aquatic bioindicators refer to:
(A) Physical fish migration tags
(B) Physiological sub-organismal level alterations
(C) Marine mammal GPS trackers
(D) Species richness quadrat counts

2023
69. Why are bivalve mollusks frequently employed in the "Mussel Watch" programs globally?
(A) Apex predator status for biomagnification
(B) Filter feeding results in bioaccumulation
(C) Synthesis of metal-neutralizing toxins
(D) Rapid excretion of all contaminants

2012
70. Arrange the following taxa in order of their typical tolerance to organic pollution, from least tolerant to most tolerant:
I. Chironomidae (bloodworms)
II. Plecoptera (stoneflies)
III. Isopoda (slaters)
(A) II, III, I
(B) I, II, III
(C) III, I, II
(D) II, I, III

2013
71. The Biological Monitoring Working Party (BMWP) score system assigns higher scores to organisms that:
(A) Are highly sensitive to pollution
(B) Are highly tolerant to pollution
(C) Have the highest biomass
(D) Reproduce the fastest

2002
72. Which physiological response in fish is a common biomarker for exposure to organophosphate pesticides?
(A) Increased metallothionein production
(B) Induction of cytochrome P450 1A (CYP1A)
(C) Elevation of vitellogenin in males
(D) Inhibition of acetylcholinesterase (AChE) activity

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2005
73. Bioconcentration Factor (BCF) is mathematically defined as the ratio of:
(A) Organism toxin to dietary levels
(B) Surrounding water to organism levels
(C) Apex predator to producer levels
(D) Organism to surrounding water levels

2006
74. Bioaccumulation differs from bioconcentration because bioaccumulation involves toxicant uptake from:
(A) Water exclusively
(B) Food sources exclusively
(C) Both water and dietary sources
(D) Sediment contact exclusively

2015
75. Biomagnification occurs primarily with toxicants that are:
(A) Lipophilic and resistant to metabolic degradation
(B) Highly water-soluble and rapidly metabolized
(C) Readily excreted via the gills
(D) Unstable under aquatic pH conditions

2012
76. The octanol-water partition coefficient ($K_{\{ow\}}$) is widely used to predict a chemical's potential for:
(A) Photodegradation
(B) Bioconcentration
(C) Hydrolysis
(D) Volatilization

2025
77. A Biomagnification Factor (BMF) greater than 1 indicates that:
(A) The organism is excreting the toxin faster than absorbing it
(B) The chemical is effectively diluted within the organism's lipid pool
(C) The organism absorbs the toxin solely via respiration
(D) The chemical concentration increases from prey to predator

2018

54. Which phytoplankton group is primarily responsible for the formation of siliceous oozes on the ocean floor?
(A) Diatoms
(B) Dinoflagellates
(C) Cyanobacteria
(D) Coccolithophores

2002

55. Epifauna and infauna are sub-classifications of:
(A) Pelagic nekton
(B) Benthic organisms
(C) Neustonic protozoans
(D) Planktonic algae

2007

56. Zooplankton vertical migration plays a key quantitative role in:
(A) Increasing surface salinity during the night
(B) Inhibiting primary production during the day
(C) Active transport of carbon to deeper ocean layers
(D) Generating tidal currents

2017

57. Which group of zooplankton is generally the most abundant secondary consumer in marine ecosystems?
(A) Chaetognaths
(B) Pteropods
(C) Salps
(D) Copepods

2025

58. Bioturbation, which significantly influences benthic nutrient cycling, is primarily driven by:
(A) Phytoplankton sinking
(B) Infaunal macrobenthos
(C) Neuston movement
(D) Bacterial chemotaxis

2013

59. The primary role of cyanobacteria in the aquatic nitrogen cycle is:
(A) Denitrification
(B) Nitrogen fixation
(C) Anammox
(D) Nitrification

2006

60. Select the correct sequence of phytoplankton size classifications from smallest to largest:
(A) Picoplankton, Nanoplankton, Microplankton, Mesoplankton
(B) Nanoplankton, Picoplankton, Mesoplankton, Microplankton
(C) Microplankton, Nanoplankton, Picoplankton, Mesoplankton
(D) Mesoplankton, Microplankton, Nanoplankton, Picoplankton

2002

61. Aquatic bioindicators are utilized primarily because they:
(A) Reflect cumulative environmental stress over time
(B) Remove the need for chemical water analysis
(C) Exhibit immunity to heavy metal toxicity
(D) Possess extremely short lifespans of hours

2009

62. In the context of water quality assessment, the EPT index relies on the abundance of which three insect orders?
(A) Ephemeroptera, Plecoptera, Trichoptera
(B) Ephemeroptera, Protura, Thysanura
(C) Ephemeroptera, Plecoptera, Thysanoptera
(D) Ephemeroptera, Plecoptera, Tipulidae

2010

63. A high EPT index value in a freshwater stream generally indicates:
(A) Severe organic pollution
(B) Excellent water quality and high dissolved oxygen
(C) High concentrations of heavy metals
(D) A dominant population of chironomid larvae

2012

64. Benthic macroinvertebrates are ideal bioindicators for all the following reasons EXCEPT:
(A) They have limited mobility, preventing them from escaping pollution
(B) Their life cycles are long enough to reflect chronic stressors
(C) They exhibit a wide range of tolerances to pollutants
(D) They are highly mobile and migrate quickly from polluted areas

2001

65. The presence of dense populations of Tubifex worms typically indicates:
(A) Oligotrophic conditions
(B) Severe organic pollution and hypoxia
(C) High levels of dissolved oxygen
(D) High salinity

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ecosystem.
Reason (R): Diverse systems exhibit higher functional redundancy, allowing alternative species to fulfill critical roles if one species is lost.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2003
91. The phenomenon where the pathway of ecosystem recovery differs from the pathway of degradation is known as:
(A) Homeorhesis
(B) Hysteresis
(C) Epistasis
(D) Synergism

2008
92. Resistance in ecological stability refers to:
(A) The ability of a system to withstand disturbance without changing its state
(B) The rate of recovery after displacement
(C) The crossing of an ecological threshold
(D) The elimination of competitors

2012
93. Which structural property typically decreases the stability of an aquatic food web?
(A) Dominance by a single keystone
(B) Prevalence of weak trophic links
(C) High functional species diversity
(D) Widespread omnivory in the system

2012
94. Disturbance in an aquatic ecosystem can be beneficial if it maintains species diversity by preventing competitive exclusion. This is the premise of the:
(A) Competitive exclusion principle
(B) Intermediate disturbance hypothesis
(C) Red Queen hypothesis
(D) Trophic cascade theory

2015
95. The "basin of attraction" in ecological stability modeling represents:
(A) The physical watershed of a lake
(B) The range of conditions within which a system tends to return to a specific equilibrium state
(C) The carrying capacity of the ecosystem
(D) The zone of maximum primary productivity

2011
96. Tipping points in aquatic ecosystems are characterized by:
(A) Slow and reversible changes
(B) Incremental biodiversity increases
(C) Total resistance to perturbations
(D) Abrupt transitions to contrasting states

2004
97. Point source aquatic pollution is characterized by:
(A) Diffuse runoff from agricultural fields
(B) Unidentifiable origins of discharge
(C) Atmospheric deposition of sulfur dioxide
(D) Discharge from a discrete, identifiable pipe, outfall, or ditch

2025
98. Cultural eutrophication is primarily driven by anthropogenic inputs of:
(A) Nitrogen and phosphorus
(B) Heavy metals and PCBs
(C) Dissolved oxygen and carbon dioxide
(D) Microplastics and synthetic fibers

2004
99. Which physiological impact is most commonly observed in fish exposed to severe hypoxia resulting from eutrophication?
(A) Enhanced reproductive success
(B) Reduced growth rates and altered swimming behavior
(C) Increased metabolic scope
(D) Hypertrophy of the swim bladder

2018
100. Match the pollutant type (List-I) with its typical source/effect (List-II).
List I: (Pollutant Type)
P. Thermal pollution
Q. Agricultural runoff
R. Acid mine drainage
S. Oil spills
List II: (Source/Effect)
1. Lowers water pH and mobilizes heavy metals
2. Coats gills and reduces oxygen diffusion in fish
3. Decreases oxygen solubility while increasing fish metabolic rate
4. Non-point source causing nutrient over-enrichment
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-4, R-3, S-2

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2022
172. Why are thermal fronts and chlorophyll gradients excellent indicators for PFZs?
(A) They denote shallow boat access
(B) They indicate toxic bloom areas
(C) They show warm spawning waters
(D) They mark high productivity zones

2023
173. The primary satellite sensor type used to estimate ocean Chlorophyll-a is:
(A) Synthetic Aperture Radar (SAR)
(B) Microwave Altimeter
(C) Optical ocean color sensor (e.g., OCM, MODIS)
(D) Thermal Infrared Radiometer

2003
174. Sea Surface Temperature (SST) is typically measured using which band of the electromagnetic spectrum?
(A) Ultraviolet
(B) Visible light
(C) Thermal infrared
(D) Gamma rays

2019
175. The major limitation of using optical sensors for Chlorophyll-a estimation is:
(A) Inability to penetrate dense cloud cover during the monsoon
(B) Low spatial resolution compared to acoustic methods
(C) High cost of sensor operation
(D) Inability to detect any phytoplankton species

2018
176. Altimetry data in remote sensing can be used to augment PFZ forecasting by identifying:
(A) Dissolved oxygen levels
(B) Fish school biomass directly
(C) Benthic vegetation cover
(D) Mesoscale ocean features like eddies and sea surface height anomalies

2013
177. A cyclonic ocean eddy in the Northern Hemisphere typically results in:
(A) Downwelling and lower productivity
(B) Upwelling of nutrient-rich water and higher productivity
(C) Massive increases in sea surface temperature
(D) Complete depletion of chlorophyll

2010
178. The economic advantage of utilizing PFZ advisories for commercial fishermen is primarily:
(A) Guaranteeing endangered catch
(B) Reduced fuel and search time
(C) Gear requirement elimination
(D) Exclusive international fishing

2025
179. A thermal front on an SST map appears as:
(A) Uniform high temperature area
(B) Localized cold water pocket
(C) Blank area with no sensor data
(D) Sharp gradient between masses

2019
180. Which of the following fish resources is best targeted using SST and Chlorophyll-based PFZ advisories?
(A) Small pelagic fish like sardines and mackerels
(B) Deep-sea demersal fish
(C) Coastal benthic mollusks
(D) Coral reef-associated sedentary species

2010
181. The range of environmental temperatures within which a poikilothermic fish can survive indefinitely is known as its:
(A) Zone of thermal tolerance
(B) Critical thermal maximum
(C) Pejus temperature
(D) Lethal threshold

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2015
182. How does an increase in water temperature generally affect the dissolved oxygen requirements of a teleost fish?
(A) Decreased metabolic requirements
(B) Increased demand despite low solubility
(C) No measurable effect on demand
(D) Permanent anaerobic respiration trigger

2019
183. Euryhaline fishes possess physiological mechanisms allowing them to:
(A) Survive in environments with no dissolved oxygen
(B) Tolerate a wide range of salinities
(C) Maintain a constant internal body temperature
(D) Reproduce exclusively in hypersaline lakes

2013
184. The migration of fish from marine environments to freshwater to spawn is termed:
(A) Catadromous migration
(B) Anadromous migration
(C) Amphidromous migration
(D) Oceanodromous migration

(B) Giant kelp
(C) Siliceous sponges
(D) Fleshy macroalgae

2024
114. The "connectivity" between mangroves, seagrass beds, and coral reefs refers to:
(A) Physical land bridge connections
(B) Identical temperature profiles
(C) Shared requirements for salinity
(D) Sequential habitat use by fish

2004
115. Destructive fishing practices like blast fishing degrade coral reefs primarily by:
(A) Altering coral genetic makeup
(B) Shattering the limestone framework
(C) Inducing severe fish hypothermia
(D) Lowering surrounding water salinity

2002
116. Which physiological mechanism explains how seagrass loss impacts local biodiversity?
(A) Removal decreases water toxicity
(B) Absence increases nocturnal oxygen
(C) Current speeds facilitate settlement
(D) Loss of refuge for juvenile fauna

2004
117. Eutrophication contributes to the degradation of seagrass beds primarily through:
(A) Promoting epiphyte growth and shading
(B) Increasing light penetration levels
(C) Nitrogen poisoning of root systems
(D) Enhancing seagrass flowering rates

2006
118. The loss of critical coastal habitats leads to an "extinction debt," which means:
(A) Species have already gone entirely extinct globally
(B) The future extinction of species due to events that occurred in the past
(C) The financial cost of restoring a habitat
(D) A website that adaptive to new environments

2018
119. Ocean acidification impacts the sensory ecology of reef fish by:
(A) Enhancing predator detection ability
(B) Improving vision in turbid waters
(C) Increasing swimming speed values
(D) Impairing olfactory discrimination

2012
120. Consider the following statements about critical habitat degradation:
I. Coastal development is a major driver of mangrove loss.
II. Coral reefs occupy less than 1% of the ocean floor but support over 25% of marine life.
III. Seagrasses are unaffected by bottom trawling practices.
IV. Habitat complexity is positively correlated with species richness.
Which of the above statement(s) is/are correct?
(A) I, II, and III
(B) I, II, and IV
(C) II, III, and IV
(D) I, III, and IV

2021
121. The Coriolis effect deflects moving water masses to the:
(A) Left in the Northern Hemisphere and right in the Southern Hemisphere
(B) Right in the Northern Hemisphere and left in the Southern Hemisphere
(C) Right in both hemispheres
(D) Equator in both hemispheres

2011
122. Ekman transport causes the net movement of surface water in the Northern Hemisphere to be oriented:
(A) Exactly parallel to the wind direction
(B) 45 degrees to the left of the wind direction
(C) 90 degrees to the right of the wind direction
(D) 180 degrees to the wind direction

2003
123. Spring tides, which exhibit the maximum tidal range, occur when:
(A) Earth, Moon, and Sun align
(B) Moon and Sun are at right angles
(C) The Earth reaches its aphelion
(D) The Moon reaches its apogee

2001
124. Major global ocean gyres are primarily driven by:
(A) Thermohaline circulation and density differences
(B) Planetary wind systems and the Coriolis effect
(C) Submarine volcanism
(D) Tidal forces

2013
125. The physical characteristic of a wind-generated ocean wave that determines its speed in deep water is:
(A) Wave height

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(D) Inverts, with warm water below cold water

2021
150. Match the ENSO phase/phenomenon (List-I) with its characteristic (List-II).
List I: (ENSO Phase/Phenomenon)
P. El Niño
Q. La Niña
R. Southern Oscillation
S. Indian Ocean Dipole
List II: (Characteristic)
1. Atmospheric pressure seesaw between Tahiti and Darwin
2. Positive phase associated with cooler eastern Indian Ocean
3. Warmer than average SST in the central/ eastern Pacific
4. Stronger than normal trade winds
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-4, R-3, S-2

2025
151. The impact of El Niño on Indian monsoon rainfall is generally associated with:
(A) Above-average rainfall and flooding
(B) Constant rainfall throughout the year
(C) Shifting the monsoon completely to the winter months
(D) Below-average rainfall and potential drought conditions

2025
152. Which ocean-atmosphere index is primarily used to monitor and forecast ENSO events?
(A) Oceanic Niño Index (ONI)
(B) Palmer Drought Severity Index
(C) Saffir-Simpson Scale
(D) Beaufort Scale

2017
153. A "positive" Indian Ocean Dipole (IOD) phase typically results in:
(A) Cooler SSTs in the western Indian Ocean and warmer in the east
(B) Warmer SSTs in the western Indian Ocean and cooler in the east
(C) Uniformly warm SSTs across the entire Indian Ocean
(D) Disappearance of the monsoon winds

2004
154. The collapse of seabird populations off the coast of South America during an El Niño event is a direct result of:
(A) Direct mortality from warm water
(B) Increased mammalian predation
(C) Starvation from anchoveta loss
(D) Atmospheric hypoxia events

2013
155. Which biological indicator species is often monitored to track the early stages of El Niño off the California coast?
(A) Benthic polychaetes
(B) Tropical fish and pelagic crabs
(C) Freshwater salmon populations
(D) Abyssal grenadier species

2013
156. ENSO is a coupled ocean-atmosphere phenomenon. "Coupled" implies that:
(A) It only occurs when the moon and sun are aligned
(B) Changes in the ocean drive changes in the atmosphere, and vice versa
(C) It happens simultaneously in the Atlantic and Pacific oceans
(D) It requires both human pollution and natural cycles to occur

2003
157. The seasonal mudbanks along the southwest coast of India are locally referred to as:
(A) Mangals
(B) Chakara
(C) Khazan
(D) Pokkali

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2015
158. Chakara formations in Kerala typically occur during which season?
(A) Pre-monsoon summer
(B) Southwest Monsoon
(C) Northeast Monsoon
(D) Post-monsoon winter

2024
159. The physical state of a mudbank is primarily characterized by:
(A) Turbulent wave-battered waters
(B) Calm waters with suspended mud
(C) Clear waters with zero solids
(D) Rapid offshore current whirlpools

2013
160. Select the correct sequence of events leading to the high fishery productivity in a Chakara system:
(A) Calm water formation → Nutrient release from mud → Phytoplankton bloom → Fish

2024
138. The direct correlation between upwelling and pelagic fishery production implies that a sudden cessation of upwelling will cause:
(A) Increase in apex predator levels
(B) Collapse of planktivorous populations
(C) Increase in benthic macrophyte
(D) No significant food web changes

2016
139. In the northern hemisphere, upwelling along a western coast is typically induced by winds blowing towards the:
(A) North
(B) South
(C) East
(D) West

2011
140. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Upwelling zones support some of the world's most productive pelagic fisheries despite occupying a small fraction of the ocean surface.
Reason (R): Upwelling supplies dissolved nutrients to the photic zone, fueling short and efficient food chains predominantly consisting of diatoms and planktivorous fish.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2008
141. Downwelling zones are generally characterized ecologically by:
(A) High primary productivity levels
(B) Low production and matter buildup
(C) Massive phytoplanktonic blooms
(D) High surface nitrate levels

2023
142. The "biological pump" in upwelling systems refers to:
(A) Physical lifting of water by wind
(B) Carbon transport via sinking matter
(C) Continuous swimming of nekton
(D) Mechanical pumping of oxygen

2022
143. Which wind system primarily drives the upwelling along the Somali coast in the Indian Ocean?
(A) The Northeast Monsoon
(B) The Southwest Monsoon
(C) The Southeast Trades
(D) The Westerlies

2023
144. High biological productivity in upwelling areas is reflected by high surface concentrations of:
(A) Dissolved silicates and nitrates
(B) Dissolved oxygen in the aphotic zone
(C) Toxic heavy metals
(D) Methane

2021
145. The El Niño phase of ENSO is characterized oceanographically by:
(A) Warm temperatures in eastern Pacific
(B) Strengthened Peruvian upwelling
(C) Cold temperatures across basin
(D) Severe downwelling off Indonesia

2010
146. How does El Niño typically impact the Peruvian Anchoveta fishery?
(A) Increases catch due to warmth
(B) Suppresses nutrient-rich upwelling
(C) Causes permanent river migration
(D) No measurable effect on fisheries

2024
147. La Niña is generally considered the "cool phase" of ENSO and results in:
(A) Weakened trade wind systems
(B) Enhanced eastern Pacific productivity
(C) Global ocean acidification
(D) Halting of the Gulf Stream

2016
148. In the Indian Ocean, the phenomenon analogous to ENSO that heavily influences regional climate and fisheries is the:
(A) Pacific Decadal Oscillation
(B) Indian Ocean Dipole (IOD)
(C) North Atlantic Oscillation
(D) Antarctic Circumpolar Wave

2010
149. During a strong El Niño event, the depth of the thermocline in the eastern equatorial Pacific typically:
(A) Shoals (becomes shallower)
(B) Deepens significantly
(C) Disappears completely

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2004
101. Eutrophication frequently leads to fish kills primarily due to:
(A) Toxicity of excessive oxygen
(B) Nocturnal oxygen depletion and decay
(C) Macrophyte clogging of gill tissue
(D) Direct toxic effects of phosphorus

2014
102. Which of the following is considered a non-point source of aquatic pollution?
(A) Municipal wastewater treatment plant effluent
(B) Industrial factory discharge pipe
(C) Urban stormwater surface runoff
(D) Oil refinery outfall

2011
103. Ammonia (NH_3) toxicity in fish is highly dependent on water pH. As pH increases, the proportion of toxic unionized ammonia:
(A) Decreases
(B) Increases
(C) Remains unchanged
(D) Converts to harmless nitrogen gas

2008
104. Endocrine-disrupting chemicals (EDCs) in aquatic environments most commonly cause which effect in fish populations?
(A) Somatic growth rate increases
(B) Enhanced immune system response
(C) Increased scale regeneration
(D) Feminization of male fish species

2015
105. "Dead zones" in coastal areas, such as the Gulf of Mexico, are primarily the result of:
(A) Overfishing of benthic species
(B) Nutrient-induced bottom-water hypoxia
(C) Point-source radioactive discharges
(D) Excessive deployment of artificial reefs

2006
106. The biochemical oxygen demand (BOD) test typically measures the amount of oxygen consumed by microorganisms over a period of:
(A) 24 hours at $10^{\circ}C$
(B) 5 days at $20^{\circ}C$
(C) 14 days at $30^{\circ}C$
(D) 1 hour at $100^{\circ}C$

2008
107. Which heavy metal pollutant is known to cause physiological disruption in fish by competing with calcium for uptake at the gill surface?
(A) Copper
(B) Arsenic
(C) Iron
(D) Cadmium

2016
108. An excess of suspended solids (turbidity) impacts fisheries resources primarily by:
(A) Increasing benthic light levels
(B) Smothering grounds and gill damage
(C) Enhancing visual predation efficacy
(D) Lowering surface water temperature

2018
109. Mangroves provide critical support for fish recruitment by functioning as:
(A) Deep-water spawning grounds
(B) Sheltered nursery habitats with food
(C) Primary sources of hypersalinity
(D) Barriers to ocean nutrient exchange

2005
110. Consider the following statements about coral reef degradation:
I. Ocean acidification reduces the availability of carbonate ions needed for calcification.
II. Coral bleaching is the expulsion of symbiotic zooxanthellae due to thermal stress.
III. Degraded reefs support higher fish biodiversity due to increased algal growth.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II, and III

2002
111. Seagrass beds are ecologically vital because they:
(A) Stabilize sediments and trap particulates
(B) Serve as primary abyssal fish habitat
(C) Thrive in highly turbid polluted waters
(D) Produce large amounts of methane gas

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2019
112. The cascading impact of mangrove deforestation on coastal fisheries usually manifests as:
(A) Increased offshore pelagic stocks
(B) Decreased coastal erosion levels
(C) Decline in shrimp and reef fish
(D) Enhanced coral reef calcification

2023
113. Coral reefs are highly vulnerable to phase shifts, where coral-dominated ecosystems degrade into systems dominated by:
(A) Mangrove saplings

aggregation
(B) Fish aggregation → Phytoplankton bloom → Calm water formation → Nutrient release
(C) Nutrient release → Calm water formation → Fish aggregation → Phytoplankton bloom
(D) Phytoplankton bloom → Calm water formation → Nutrient release → Fish aggregation

2024
161. The hydrodynamic mechanism responsible for wave damping in a mudbank is:
(A) Refraction by offshore reefs
(B) Energy loss in viscous fluid mud
(C) Tidal current interference
(D) Offshore wind flattening effects

2005
162. Which fishery resources are most predominantly harvested from the Kerala mudbanks?
(A) Deep-sea squids and octopuses
(B) Prawns, sardines, and mackerels
(C) Benthic lobsters and crabs
(D) Tuna and billfishes

2013
163. The formation of mudbanks has been hypothesized to be influenced by:
(A) Sub-surface mud upwelling
(B) Subterranean discharge and rips
(C) Sea floor volcanic eruptions
(D) Annual macroalgae die-offs

2010
164. The phenomenon of Chakara serves a critical socio-economic function by providing:
(A) Safe landing sites during monsoon
(B) Harbors for large cargo vessels
(C) Scuba diving tourist locations
(D) Salt extraction pan facilities

2006
165. The high nutrient content in mudbank waters is primarily due to:
(A) Rain-driven agricultural runoff
(B) Sediment release from agitation
(C) Aggregated fish population waste
(D) Nitrogen fixation by lightning

2018
166. Identify the INCORRECT statement about mudbanks.
(A) They are transient formations appearing mainly between June and August
(B) They migrate slowly along the coastline from year to year
(C) The water within the mudbank exhibits high wave action and turbulence
(D) The bottom mud is highly cohesive and fine-grained

2021
167. Which specific physical property allows the clay particles in a mudbank to remain in suspension for extended periods?
(A) Large size and high gravity
(B) Salinity-driven deflocculation
(C) Absolute lack of particle charge
(D) Rapid crystallization into sand

2025
168. The dominant clay mineral found in the sediments of Kerala mudbanks is:
(A) Kaolinite
(B) Montmorillonite
(C) Illite
(D) Chlorite

2023
169. Potential Fishing Zones (PFZs) in India are forecast primarily by integrating data from which two satellite-derived parameters?
(A) Sea Surface Temperature (SST) and Chlorophyll-a concentration
(B) Sea Surface Salinity and Wind Speed
(C) Wave Height and Ocean Color
(D) Bathymetry and Lunar Phases

2022
170. Arrange the typical workflow for generating and disseminating PFZ advisories:
I. Satellite data acquisition (SST and Chlorophyll)
II. Data processing and feature extraction (fronts, eddies)
III. Integration and generation of PFZ maps
IV. Dissemination to end-users via SMS/ electronic boards
(A) I, II, III, IV
(B) II, I, III, IV
(C) I, III, II, IV
(D) III, I, II, IV

2015
171. In India, the nodal agency responsible for generating and disseminating PFZ advisories is:
(A) Indian National Centre for Ocean Information Services (INCOIS)
(B) Fishery Survey of India (FSI)
(C) Central Marine Fisheries Research Institute (CMFRI)
(D) Space Applications Centre (SAC)

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(A) Blocking voltage-gated sodium channels
(B) Inhibiting protein phosphatase enzymes
(C) Destroying red blood cells directly
(D) Inducing continuous nerve cell firing

2002
197. Diarrhetic Shellfish Poisoning (DSP) is caused by the ingestion of bivalves contaminated with:
(A) Ciguatoxin
(B) Okadaic acid
(C) Saxitoxin
(D) Microcystin

2014
198. Fish kills during a non-toxic phytoplankton bloom are predominantly the result of:
(A) Algal ingestion hemorrhaging
(B) Heavy metal bioaccumulation
(C) Sudden temperature drops
(D) Gill clogging or oxygen depletion

2014
199. Cyanobacterial HABs in freshwater systems frequently produce hepatotoxins known as:
(A) Saxitoxins
(B) Microcystins
(C) Domoic acids
(D) Brevetoxins

2017
200. Match the biotoxin (List-I) with its corresponding clinical syndrome (List-II).
List I: (Biotoxin)
P. Saxitoxin
Q. Domoic acid
R. Okadaic acid
S. Brevetoxin
List II: (Clinical Syndrome)
1. Amnesic Shellfish Poisoning (ASP)
2. Diarrhetic Shellfish Poisoning (DSP)
3. Paralytic Shellfish Poisoning (PSP)
4. Neurotoxic Shellfish Poisoning (NSP)
(A) P-3, Q-1, R-2, S-4
(B) P-1, Q-3, R-4, S-2
(C) P-3, Q-2, R-1, S-4
(D) P-4, Q-1, R-2, S-3

2021
201. Ciguatera Fish Poisoning (CFP) is contracted by consuming:
(A) Temperate filter-feeding bivalves
(B) Reef predators with bioaccumulated toxins
(C) Direct freshwater cyanobacteria
(D) Farmed Atlantic salmon stocks

2012
202. The causative organism for the Florida red tide, which frequently results in massive marine life mortality, is:
(A) Alexandrium tamarense
(B) Microcystis aeruginosa
(C) Dinophysis acuminata
(D) Karenia brevis

2001
203. Which environmental factor is heavily implicated in increasing the frequency and intensity of global HABs?
(A) Reduction in atmospheric carbon dioxide
(B) Decreased use of agricultural fertilizers
(C) Expansion of marine protected areas
(D) Anthropogenic coastal eutrophication and global warming

2006
204. Saxitoxin exerts its lethal paralytic effect by:
(A) Binding and opening calcium channels
(B) Causing massive liver necrosis
(C) Denaturing hemoglobin
(D) Blocking nerve impulse transmission

NODIA

2002
205. In-situ bioremediation of an aquatic system refers to:
(A) Excavating contaminated sediment for treatment in a separate facility
(B) Treating the contamination at the site without removing the polluted material
(C) Adding chemical oxidants to drinking water
(D) Incinerating the polluted water

2021
206. Bioaugmentation, as an aquatic restoration technique, involves:
(A) Stimulating indigenous microbes by adding nutrients
(B) The addition of specifically cultured, specialized microbial strains to degrade a target pollutant
(C) Physically removing macro-pollutants using dredges
(D) Introducing an apex predator to control pest fish

2009
207. Biostimulation differs from bioaugmentation in that biostimulation primarily involves:
(A) Adding exogenous bacterial strains
(B) Metal extraction using plants
(C) Applying ultraviolet radiation
(D) Modifying conditions for native microbes

2005
185. Which vital process in fish is directly regulated by the photoperiod and temperature cycles?
(A) Gonad maturation and spawning
(B) Number of developed fin rays
(C) Heavy metal liver synthesis
(D) Birth otolith physical size

2022
186. During osmoregulation in a marine teleost, the gills actively:
(A) Excrete excess monovalent ions (e.g., Na^+, Cl^-)
(B) Absorb salts from the surrounding water
(C) Excrete large volumes of dilute urine
(D) Retain urea to match ambient osmolarity

2015
187. "Winter flounder" and other temperate species exhibit seasonal migrations primarily to:
(A) Avoid hypersalinity in the summer
(B) Seek optimal temperature regimes for feeding and reproduction
(C) Find anoxic bottom waters for hibernation
(D) Escape photic zone predators

2017
188. Hypoxia fundamentally limits the spatial distribution of fish because:
(A) It increases water density levels
(B) Fish lack ATP for basic metabolism
(C) It causes instant water acidity
(D) Viscosity prevents swimming motion

2008
189. The "Oxygen- and Capacity-Limited Thermal Tolerance" (OCLTT) hypothesis suggests that a fish's thermal tolerance is restricted primarily by:
(A) Cell membrane physical melting
(B) Oxygen supply capacity to tissues
(C) Availability of dietary lipids
(D) Photoperiod duration cycles

2023
190. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Freshwater teleosts constantly excrete large volumes of highly dilute urine.
Reason (R): They live in a hypotonic environment and constantly gain water by osmosis across their gills.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

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2010
191. The preferred temperature of a fish species generally aligns closely with the temperature at which:
(A) Maximum growth and metabolic efficiency occur
(B) The immune system is completely deactivated
(C) Spawning is completely inhibited
(D) Water freezes

2007
192. Which phenomenon describes the mass death of fish in a shallow, highly productive pond following a sequence of hot, cloudy days?
(A) Cold shock
(B) Summer kill due to severe nocturnal oxygen depletion
(C) Hypercapnia from excessive photosynthesis
(D) Ammonia volatilization

2004
193. Harmful Algal Blooms (HABs) known as "Red Tides" are most frequently caused by rapid proliferation of:
(A) Diatoms
(B) Green algae
(C) Silicoflagellates
(D) Dinoflagellates

2024
194. Paralytic Shellfish Poisoning (PSP) is primarily caused by which potent neurotoxin produced by HABs?
(A) Domoic acid
(B) Okadaic acid
(C) Brevetoxin
(D) Saxitoxin

2022
195. Amnesic Shellfish Poisoning (ASP) is uniquely associated with the toxin domoic acid, which is produced primarily by certain species of:
(A) Cyanobacteria
(B) Diatoms (e.g., Pseudo-nitzschia)
(C) Dinoflagellates
(D) Ciliates

2021
196. The mechanism by which brevetoxins (associated with Neurotoxic Shellfish Poisoning) affect marine organisms and humans is by:

(B) Wavelength
(C) Water depth
(D) Wave steepness

2016

126. A wave breaks as it approaches the shore because:
(A) Wave period decreases drastically
(B) Bottom friction slows wave bases
(C) Coriolis causes spinning motions
(D) Wind direction reverses at coast

2023

127. Thermohaline circulation is driven by global gradients in:
(A) Surface wind stress and atmospheric pressure
(B) Temperature and salinity
(C) Lunar and solar gravitational pull
(D) Phytoplankton density

2009

128. Neap tides occur during which lunar phases?
(A) New moon and full moon
(B) First quarter and third quarter moons
(C) Waxing gibbous only
(D) Waning crescent only

2024

129. The boundary currents on the western side of subtropical gyres (e.g., the Gulf Stream) are typically:
(A) Broad, shallow, and slow-moving
(B) Narrow, deep, and fast-moving
(C) Cold and nutrient-rich
(D) Non-existent in the Northern Hemisphere

2022

130. Consider the following statements regarding ocean physics:
I. Deep water waves do not interact with the ocean bottom.
II. Tsunami waves behave as shallow-water waves because their wavelengths are immensely long.
III. The Coriolis effect is strongest at the equator.
IV. Tidal cycles are solely determined by the Sun's gravity.
V. Ekman spirals describe the change in current speed and direction with depth.
Which of the above statement(s) is/are INCORRECT?
(A) I and II
(B) III and IV
(C) I, II, and V
(D) II, III, and V

2018

131. Wave height is primarily determined by wind speed, wind duration, and:
(A) Coriolis force
(B) Fetch
(C) Salinity
(D) Water temperature

2005

132. The semi-diurnal tidal pattern is characterized by:
(A) One high tide and one low tide
(B) Continuous high water for hours
(C) Two equal high and low tides
(D) Two significantly unequal tides

2001

133. Coastal upwelling occurs when wind-driven Ekman transport moves surface water:
(A) Towards the coastline
(B) Away from the coastline
(C) Parallel to the equator
(D) Downward into the deep ocean

2023

134. Upwelling regions are biologically significant because they:
(A) Bring warm water to the surface
(B) Create anoxic deep dead zones
(C) Eliminate phytoplankton blooms
(D) Fuel photic zone primary production

2014

135. Coastal downwelling is typically associated with:
(A) Enhanced pelagic fishery production
(B) High surface nutrient concentrations
(C) Winds moving surface water towards the coast, pushing it downward
(D) Divergence of surface currents at the equator

2018

136. Which major global fishery is highly dependent on the upwelling system off the west coast of South America?
(A) Atlantic Cod
(B) Alaskan Pollock
(C) Peruvian Anchoveta
(D) Bluefin Tuna

2004

137. Equatorial upwelling is driven by the divergence of surface currents due to:
(A) Hurricane force wind activity
(B) Tidal bore action at equator
(C) Submarine earthquake events
(D) Trade winds and Coriolis reversal

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2011
208. Phytoremediation utilizes which group of organisms to clean up aquatic pollution?
(A) Aquatic plants and macroalgae
(B) Fungi
(C) Heterotrophic bacteria
(D) Bivalve mollusks

2021
209. Constructed wetlands are a widely used bioprocess technology designed to:
(A) Generating electricity from flow
(B) Mimic natural wastewater treatment
(C) Breed sensitive fish species
(D) Evaporate toxic waste volumes

2003
210. Consider the following statements about bioremediation:
I. Ex-situ techniques generally allow for better control of treatment conditions.
II. In-situ techniques are usually more disruptive to the ecosystem than ex-situ techniques.
III. Bioaugmentation can fail if the introduced microbes cannot compete with indigenous flora.
Which of the above statement(s) is/are correct?
(A) I and II
(B) I and III
(C) II and III
(D) I, II, and III

2001
211. The application of white-rot fungi for the degradation of complex aquatic organic pollutants (like PCBs) is termed:
(A) Mycoremediation
(B) Phycoremediation
(C) Rhizofiltration
(D) Phytostabilization

2009
212. Which engineered bioprocess is frequently used to treat hypersaline aquaculture effluent?
(A) Methanogenic digesters
(B) Plain sedimentation
(C) Standard freshwater activated sludge
(D) Halophilic microbial bioreactors

2003
213. Rhizofiltration is an ex-situ or in-situ application where:
(A) Fungi decompose floating oil
(B) Algae sequester atmospheric carbon
(C) Microbes are injected into aquifers
(D) Plant roots absorb toxic metals

2004
214. The effectiveness of aerobic microbial degradation of organic pollutants in water is most strongly limited by the availability of:
(A) Carbon dioxide
(B) Dissolved oxygen
(C) Heavy metals
(D) High pressure

2018
215. Which bioremediation strategy is typically deployed following a marine oil spill?
(A) Adding fertilizers (N and P) to biostimulate indigenous hydrocarbon-degrading bacteria
(B) Introducing massive quantities of heavy metals
(C) Pumping the ocean water into bioreactors
(D) Planting seagrasses directly into the slick

2013
216. What is a significant drawback of ex-situ bioremediation of contaminated aquatic sediments?
(A) It provides too much control over environmental parameters
(B) High cost and logistical difficulties associated with dredging and transportation
(C) It strictly requires anaerobic conditions
(D) It only works on organic compounds

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2001
217. Ecological biomanipulation for restoring eutrophic lakes fundamentally relies on:
(A) Applying chemical algicides repeatedly
(B) Dredging the entire lake bottom
(C) Pumping oxygen into the hypolimnion
(D) Altering the food web structure to reduce phytoplankton biomass

2016
218. A classic top-down biomanipulation strategy to control algal blooms involves:
(A) Apex predator removal
(B) Stocking piscivores to boost grazers
(C) Inorganic fertilizer additions
(D) Non-grazing herbivorous fish

2004
219. Bottom-up control of a eutrophic water body focuses primarily on:
(A) Reducing external and internal nutrient loading (e.g., phosphorus reduction)
(B) Altering the apex predator community
(C) Harvesting aquatic macrophytes
(D) Introducing exotic zooplankton

2009
242. The Contingent Valuation Method (CVM) assesses the economic value of an ecosystem service by:
(A) Surveying willingness to pay (WTP)
(B) Calculating market prices of timber
(C) Estimating travel expenses to sites
(D) Correlating property with quality

2002
243. To estimate the recreational value of a coastal marine park, the most appropriate non-market valuation technique is the:
(A) Hedonic pricing method
(B) Replacement cost method
(C) Market price approach
(D) Travel cost method

2014
244. The Hedonic Pricing Method is commonly used to estimate the value of environmental amenities by examining:
(A) Travel costs to the amenity
(B) Differences in real estate pricing
(C) Damage repair costs from pollution
(D) Consumer compensation surveys

2015
245. The "Replacement Cost Method" values an ecosystem service (like a mangrove's storm protection) based on:
(A) Market value of mangrove timber
(B) Fishermen income loss estimates
(C) Aesthetic value of the trees
(D) Construction costs of infrastructure

2012
246. In environmental economics, "option value" refers to:
(A) The current revenue generated from fishing licenses
(B) The value placed on conserving a resource for potential future direct or indirect use
(C) The exact market price of the raw materials
(D) The cost of restoring a fully degraded habitat

2008
247. A major limitation of the Contingent Valuation Method (CVM) is:
(A) It requires extensive travel data
(B) It is susceptible to hypothetical bias, where respondents overstate or understate their true willingness to pay
(C) It can only be used for marketed goods
(D) It inherently ignores non-use values

2016
248. The economic value derived from the regulatory functions of aquatic ecosystems, such as water purification and carbon sequestration, is classified as:
(A) Direct use value
(B) Indirect use value
(C) Existence value
(D) Option value

2016
249. Shadow pricing in environmental economics refers to:
(A) The black market price of illegal wildlife
(B) An assigned monetary value to an unpriced environmental asset or service based on its true opportunity cost
(C) The price of goods sold at night
(D) Subsidized market prices

2019
250. Match the valuation method (List-I) with its primary application context (List-II).
List I: (Valuation Method)
P. Travel Cost Method
Q. Hedonic Pricing
R. Contingent Valuation
S. Replacement Cost
List II: (Application Context)
1. Assessing the value of coastal real estate
2. Estimating existence value of an endangered species
3. Valuing a recreational fishing site
4. Valuing natural coastal flood defense
(A) P-3, Q-1, R-2, S-4
(B) P-4, Q-2, R-1, S-3
(C) P-1, Q-4, R-3, S-2
(D) P-3, Q-4, R-1, S-2

2017
251. Which of the following best represents a "direct use value" of a coral reef?
(A) Commercial harvesting of reef fish and lobsters
(B) Carbon sequestration
(C) Coastal erosion control
(D) The knowledge that the reef simply exists

2017
252. The Total Economic Value (TEV) framework of an ecosystem is mathematically the sum of:
(A) Use values and non-use values
(B) Direct values and market values
(C) Option values and existence values only
(D) Capital costs and operational costs

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Identify the correct sequential combination of these stages.
(A) II, III, IV, I, V
(B) I, II, III, IV, V
(C) III, II, IV, I, V
(D) II, IV, III, V, I

2019
231. The term "microfouling" refers specifically to the accumulation of:
(A) Barnacles and tunicates
(B) Marine borers
(C) Biofilms containing bacteria, diatoms, and protozoa
(D) Large seaweeds

2023
232. An enormous economic impact of marine biofouling on the shipping industry is:
(A) Increased buoyancy of the vessels
(B) Rapid corrosion of stainless steel propellers
(C) Enhanced maneuverability of ships
(D) Increased drag and fuel consumption

2001
233. The highly effective anti-fouling biocide Tributyltin (TBT) was globally banned because it:
(A) Caused severe endocrine disruption
(B) Failed to prevent barnacle settlement
(C) Caused rapid rusting of ship hulls
(D) Promoted the growth of toxic algal blooms

2015
234. In aquaculture, biofouling on net cages is detrimental because it:
(A) Increases the structural integrity of the nets
(B) Provides a highly nutritious supplemental diet for all cultured species
(C) Repels parasitic sea lice
(D) Reduces water flow and oxygen exchange

2024
235. Which group of organisms is classified as hard macrofoulers?
(A) Sea squirts (Tunicates)
(B) Barnacles and tube worms
(C) Sponges
(D) Hydroids

2018
236. Modern environmentally friendly anti-fouling coatings often rely on:
(A) Extremely high concentrations of copper and lead
(B) Constant electric shocks emitted into the water
(C) Radioactive isotopes
(D) Low-energy hydrophobic polymers

2005
237. The "ecological trap hypothesis" in the context of biofouling and artificial structures suggests that:
(A) Fouling organisms prefer toxic surfaces
(B) Structures attract species to sub-optimal zones
(C) Biofouling prevents invasive establishment
(D) Marine structures disintegrate over time

2009
238. Biofouling facilitates the spread of invasive species primarily through:
(A) Wind dispersion
(B) Hull fouling on international commercial vessels and recreational boats
(C) Atmospheric deposition
(D) Ocean currents reversing direction

2022
239. Which biological mechanism do many marine organisms (e.g., corals, sponges) use naturally to prevent biofouling on their surfaces?
(A) Exudation of secondary metabolites
(B) Rapid swimming speed adjustments
(C) Boiling internal body temperatures
(D) Daily shedding of entire body walls

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2014
240. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The application of copper-based paints is fully sustainable and poses zero ecological risk to estuarine environments.
Reason (R): Copper is an essential micronutrient for all aquatic flora and fauna.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2015
241. Economic valuation of aquatic ecosystems recognizes their "non-use values," which include:
(A) Direct harvesting of fish for the market
(B) Extraction of sand and minerals
(C) Existence value and bequest value
(D) Revenue from commercial aquaculture

(A) Tides, waves, sea-level rise, and shoreline changes
(B) Only historical earthquake epicenters
(C) The population density of coastal cities
(D) The migration routes of marine mammals

2001

265. Vulnerability assessments for coastal fishing communities typically evaluate three key components:
(A) Exposure, sensitivity, and adaptive capacity
(B) Capital, profit, and loss
(C) Age, weight, and height of fishers
(D) Tides, currents, and salinity

2007

266. In the context of disaster risk reduction (DRR), "adaptive capacity" refers to:
(A) Physical storm intensity levels
(B) Fisheries economic dependence levels
(C) Ability to cope and adjust
(D) Maximum systemic carrying capacity

2014

267. Early warning systems for coastal hazards (like tsunamis or cyclones) are most effective when they feature:
(A) Highly technical scientific jargon
(B) Confirmations via printed newspapers
(C) Alerts for commercial vessels only
(D) End-to-end community communication

2012

268. A community's "sensitivity" to coastal hazards is heavily increased by:
(A) Diversified income sources
(B) Robust coastal defense infrastructure
(C) Comprehensive insurance coverage
(D) High dependence on a single livelihood, such as near-shore fishing

2016

269. Soft engineering solutions for disaster risk reduction along coasts include:
(A) Constructing massive concrete seawalls
(B) Mangrove afforestation and dune restoration
(C) Deploying massive concrete tetrapods
(D) Building offshore oil rigs

2001

270. Disaster Risk Reduction (DRR) emphasizes transitioning from a reactive approach to a proactive approach, which means focusing heavily on:
(A) Post-disaster relief and body recovery
(B) Preparedness, mitigation, and early warning
(C) Requesting international aid after a catastrophe
(D) Abandoning coastal areas entirely

2016

271. An example of an institutional coping mechanism for fishing communities during the cyclone season is:
(A) Individual fishers upgrading their boat engines
(B) Government-implemented fishing bans matched with livelihood compensation schemes
(C) Fishers relying on personal savings
(D) Migration to urban slums

2024

272. Community-based Disaster Risk Management (CBDRM) ensures that:
(A) The military takes complete control of fishing villages
(B) All funding is diverted to federal agencies
(C) Risk assessment is conducted via remote sensing exclusively
(D) Local knowledge and community participation are central to formulating DRR plans

2025

273. The primary international framework guiding disaster risk reduction globally is the:
(A) Kyoto Protocol
(B) Sendai Framework for Disaster Risk Reduction
(C) Montreal Protocol
(D) Convention on Biological Diversity

2014

274. For coastal fishers, a reliable indicator of a highly functional early warning system is:
(A) Warnings issued after disaster strikes
(B) Multi-channel alerts in local languages
(C) Strictly satellite television broadcasts
(D) Scientific terminology-heavy advisories

2005

275. Coastal vulnerability to storm surges is critically exacerbated by the long-term anthropogenic factor of:
(A) Global sea-level rise
(B) Decreased ocean salinity
(C) Enhanced upwelling
(D) Increased primary productivity

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2013
253. The primary objective of Integrated Coastal Zone Management (ICZM) is to:
(A) Maximize coastal industry growth
(B) Balance economic and social sustainability
(C) Halt human coastal sea activity
(D) Centralize governance to local levels

2002
254. Under the Coastal Regulation Zone (CRZ) notification in India, ecologically sensitive areas like mangroves, coral reefs, and national parks are classified under:
(A) CRZ-I
(B) CRZ-II
(C) CRZ-III
(D) CRZ-IV

2008
255. CRZ-IV under the Indian regulatory framework typically encompasses:
(A) Highly developed urban coastal areas
(B) Relatively undisturbed rural coastal areas
(C) The water area from the Low Tide Line to 12 nautical miles seaward
(D) Inland freshwater rivers

2014
256. Which of the following zones is classified as CRZ-II?
(A) Ecologically sensitive bio-reserves
(B) Coastal areas that are relatively undisturbed and do not fall under I or II
(C) The territorial sea
(D) Coastal areas that have been substantially built up or are located within municipal limits

2019
257. The seaward boundary for coastal regulation under the CRZ notification in India is measured up to the territorial limit, which is:
(A) 5 nautical miles
(B) 12 nautical miles
(C) 200 nautical miles
(D) The edge of the continental shelf

2017
258. One of the core principles of ICZM is a "multi-sectoral approach," meaning:
(A) Managing fisheries, tourism, and conservation independently with no overlap
(B) Integrating policies and management practices across all economic sectors operating in the coastal zone
(C) Allowing multiple international corporations to exploit resources
(D) Focusing exclusively on a single sector at a time

2007
259. The "No Development Zone" (NDZ) in rural coastal areas (CRZ-III) according to recent CRZ amendments generally extends up to how many meters from the High Tide Line (HTL)?
(A) 50 meters or 200 meters, depending on the population density
(B) 500 meters uniformly
(C) 1000 meters uniformly
(D) 10 meters uniformly

2017
260. The baseline from which the CRZ limits are primarily delineated is the:
(A) High Tide Line (HTL)
(B) Low Tide Line (LTL)
(C) Mean Sea Level (MSL)
(D) Edge of the Exclusive Economic Zone

2004
261. In the context of ICZM, "stakeholder participation" implies:
(A) Only government scientists make decisions
(B) Engaging local communities, industries, and governments collaboratively in the planning process
(C) Selling shares of coastal property to international investors
(D) Ignoring the indigenous knowledge of traditional fishers

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2015
262. Which coastal habitat is explicitly protected from any new construction or development under CRZ-I due to its geomorphological importance?
(A) Heavily concreted urban harbors
(B) Sand dunes
(C) Abandoned aquaculture ponds
(D) Commercial salt pans

2011
263. A fundamental tool used in ICZM to assess the potential environmental impacts of a proposed large-scale coastal project is:
(A) Contingent Valuation
(B) Catch Per Unit Effort estimation
(C) Maximum Sustainable Yield modeling
(D) Environmental Impact Assessment (EIA)

2010
264. The hazard line mapped along the Indian coast for disaster management takes into account:

headwaters to the flatter river mouth, while nearby terrestrial riparian vegetation contributes significant allochthonous energy inputs through falling leaves. Conversely, turbidity usually increases downstream due to cumulative sediment accumulation and phytoplankton growth, contradicting the claim that turbidity decreases downstream.

11. (A) Unidirectional continuous water flow
Lotic ecosystems, such as rivers and streams, are primarily distinguished from standing water lentic systems by their continuous, unidirectional water flow. This constant movement acts as a major selective force, shaping channel morphology, transporting nutrients downstream, and requiring resident organisms to develop specialized morphological adaptations to prevent being swept away.

12. (C) Vertical organic matter transport to benthos
Marine snow consists of falling organic debris, dead plankton, fecal pellets, and mucus that continuously drift down from the upper ocean layers to the deep seafloor. This material serves as a primary vehicle for carbon export, providing a critical source of food and energy for heterotrophic organisms living in the food-limited aphotic and benthic zones.

13. (D) Total autotrophic organic carbon production
Gross primary productivity represents the total rate at which autotrophic organisms, such as phytoplankton and macrophytes, convert solar or chemical energy into organic carbon within an aquatic ecosystem. This measurement encompasses the entire biochemical energy harvested prior to any respiratory losses by the primary producers themselves during cellular metabolism.

14. (C) Carbon-14 (^{14}C) radiotracer technique
The radioactive carbon-14 technique is highly sensitive and ideal for measuring primary productivity in nutrient-poor oligotrophic waters where metabolic rates are too low for detectable dissolved oxygen changes. By tracing the incorporation of labeled inorganic carbon into organic matter, researchers can accurately quantify minimal rates of carbon fixation over short incubation periods.

15. (B) Community respiration
In the light and dark bottle method, the dark bottle is completely shielded from sunlight, preventing photosynthesis while allowing cellular respiration to continue. The decline in dissolved oxygen within this dark bottle over the incubation period directly reflects the collective rate of respiration by the entire planktonic community, including phytoplankton, zooplankton, and bacteria.

16. (C) Maximum sustainable environmental population
Carrying capacity is the maximum population size of a biological species that a specific aquatic habitat can sustainably support over time. This limit is determined by available environmental resources such as food, dissolved oxygen, breeding substrates, and space, as well as ecological pressures like predation, disease, and waste accumulation.

17. (D) Heterotrophs
Secondary productivity in an aquatic ecosystem refers to the rate at which heterotrophic organisms, including zooplankton, macroinvertebrates, and fish, accumulate biomass by consuming other organisms. This process represents the transfer and assimilation of organic energy up the food web, reflecting how efficiently consumers utilize ingested food for growth and reproduction.

18. (B) $60 gCm^{-2} yr^{-1}$
Net primary productivity is calculated by subtracting autotrophic respiration from gross primary productivity within an aquatic ecosystem. Using the provided values of one hundred units for gross production and forty units for respiratory expenditure, the remaining sixty units represent the actual rate of organic carbon accumulation available for consumer trophic levels.

19. (C) It is less sensitive than the oxygen evolution method
The carbon-14 technique is far more sensitive than the traditional dissolved oxygen method, making it the preferred choice for measuring low primary productivity in oligotrophic waters. It involves incubating water samples with radioactive bicarbonate, filtering the plankton post-incubation, and measuring the incorporated radioactivity to estimate the rate of carbon fixation.

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2011
276. Resilience in the context of coastal community DRR is best demonstrated by:
(A) A community suffering total economic collapse after a storm
(B) A community recovering rapidly and "building back better" after a hazard event
(C) A community ignoring all early warnings
(D) A community permanently abandoning their ancestral lands

2010
277. Artificial Reefs (ARs) enhance coastal habitats primarily by:
(A) Increasing local water temperature
(B) Providing substrate for fish biomass
(C) Emitting chemical attractants daily
(D) Reducing dissolved oxygen levels

2017
278. The ecological succession on a newly deployed artificial reef typically begins with:
(A) Climax macroalgae settlement
(B) Formation of a bacterial and diatom biofilm
(C) Immediate colonization by apex piscivores
(D) Settlement of hard corals

2025
279. Which material is highly discouraged for constructing artificial reefs due to environmental toxicity and structural instability?
(A) Concrete module designs
(B) Prepared decommissioned steel vessels
(C) Scrap tires with nylon ropes
(D) Natural quarried limestone boulders

2024
280. The "attraction vs. production" debate regarding artificial reefs questions whether ARs:
(A) Draw tourists or produce fish
(B) Increase biomass or aggregate fish
(C) Produce toxins or attract species
(D) Attract plankton or produce waste

2023
281. The deployment of complex, multi-level concrete artificial reef modules primarily aims to:
(A) Increase habitat and niche availability
(B) Create smooth anti-biofouling surfaces
(C) Maximize satellite imagery aesthetics
(D) Increase ocean current speed values

2004
282. To mimic the complexity of a natural coral reef, artificial reefs are designed to have high:
(A) Buoyancy
(B) Interstitial space (crevices and holes)
(C) Acoustic reflectivity
(D) Solubility in seawater

2014
283. One of the primary biological indicators of a stable and mature artificial reef community is:
(A) Abundance of transient pelagic fish
(B) Single pioneer bacterial dominance
(C) Presence of long-lived macro-benthos
(D) Total absence of grazing herbivores

2019
284. Benthic succession on an artificial reef is heavily influenced by factors such as:
(A) Depth, light penetration, current speed, and substrate orientation
(B) Only the brand of concrete used
(C) The color of the deployed structure
(D) The lunar phase precisely on the day of deployment

2001
285. A major risk of deploying artificial reefs without proper geographic planning is:
(A) Local biodiversity enhancement
(B) Trawling ground conflict and snagging
(C) Excessive dissolved oxygen production
(D) Ocean salinity level reduction

2021
286. Which feature of an artificial reef design best facilitates the survival of juvenile fishes?
(A) Large open chambers with wide exits
(B) High density of small complex refugia
(C) Perfectly smooth exterior surfaces
(D) Deployment in the aphotic zone

2016
287. Decommissioned oil rigs left in the ocean to serve as habitats are an application of the concept known as:
(A) Bioaugmentation
(B) Rigs-to-Reefs
(C) Pelagic trawling
(D) Phytoremediation

2015
288. Compared to natural reefs, artificial reefs generally exhibit:
(A) Identical composition within weeks
(B) Climate-dependent climax communities
(C) Zero primary production levels
(D) Exclusively pelagic fish species

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2003

220. Consider the following trophic cascade statements regarding biomanipulation:

I. An increase in piscivores leads to a decrease in planktivores.
II. A decrease in planktivores leads to an increase in large grazing zooplankton (e.g., Daphnia).
III. An increase in large zooplankton leads to an increase in phytoplankton biomass.
IV. Biomanipulation is an application of the top-down control model.

Which of the above statement(s) is/are correct?
(A) I, II, and IV
(B) II, III, and IV
(C) I, III, and IV
(D) I, II, and III

2002

221. Which large zooplankter is generally the most effective grazer targeted for enhancement during lake biomanipulation?
(A) Rotifers
(B) Daphnia (Cladocera)
(C) Small copepods
(D) Chaetognaths

2022

222. Cyanobacteria are notoriously difficult to control via traditional biomanipulation (zooplankton grazing) because:
(A) They are obligate anaerobes
(B) They are toxic and poorly nutritious
(C) They grow in deep aphotic waters
(D) They synthesize palatable sugars

2009

223. What role do submerged aquatic macrophytes play in successful shallow lake biomanipulation?
(A) Nutrient sources for algae
(B) Refuge for grazers and stabilization
(C) Zooplankton consumer role
(D) Physical phytoplankton exclusion

2010

224. "Planktivore removal" (e.g., netting out roach and bream) is a technique used to:
(A) Increase the turbidity of the water
(B) Directly enhance the survival and size of herbivorous zooplankton
(C) Eliminate the piscivorous fish entirely
(D) Increase internal phosphorus loading

2018

225. Biomanipulation interventions often face long-term instability due to:
(A) Permanent extinction of all phytoplankton
(B) Rebound of planktivore populations or compensation by inedible algae
(C) Complete cessation of external nutrient inputs
(D) Over-oxygenation of the water

2007

226. In the context of alternative stable states, biomanipulation aims to shift a shallow lake from a:
(A) Clear-water macrophyte state to a turbid phytoplankton state
(B) Turbid phytoplankton state to a clear-water macrophyte state
(C) Benthic state to a pelagic state
(D) Oligotrophic state to a hypertrophic state

2021

227. Bottom-up biomanipulation techniques to reduce internal phosphorus loading often include:
(A) Adding nitrogen gas to the water
(B) Stocking bottom-feeding fish like common carp
(C) Removing aquatic plants
(D) Adding alum to precipitate phosphorus

2017

228. Benthivorous fish (like carp) negatively impact lake restoration efforts by:
(A) Consuming all the piscivorous fish
(B) Eating excessive amounts of phytoplankton
(C) Providing excessive refuge for zooplankton
(D) Resuspending mud and releasing nutrients

2023

229. Marine biofouling begins immediately upon submergence of a solid surface with the formation of a:
(A) Calcareous shell layer
(B) Conditioning film of adsorbed organic molecules
(C) Dense macroalgal canopy
(D) Barnacle settlement

2014

230. Consider the following stages of marine biofouling:

I. Settlement of macrofoulers (e.g., barnacles, mussels)
II. Formation of a biochemical conditioning film
III. Attachment of primary colonizing bacteria to form a biofilm
IV. Settlement of secondary colonizers (e.g., protozoa, diatoms)
V. Climax community of complex macrofouling

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ANSWERS

1. (A) Deep-water zone below effective light penetration
The profundal zone is the deep, cold area of a freshwater lake where light penetration is insufficient to support photosynthesis. This layer lies below the thermocline and is characterized by low oxygen concentrations and high pressure, preventing primary production and relying on organic matter drifting down from warmer, well-lit surface waters.

2. (C) River continuum concept
The river continuum concept describes the predictable downstream gradient of physical variables and the continuous structural and functional adaptations of biological communities in running water systems. This framework links physical stream size, geomorphological features, and energy source shifts to the distribution of shredders, collectors, grazers, and predators from headwaters to the river mouth.

3. (A) Salinity
Salinity exhibits the most pronounced vertical stratification in estuaries because freshwater input from rivers is less dense and floats over the denser saltwater invading from the ocean. This density difference creates a distinct salt wedge where salinity levels transition sharply with depth, significantly influencing the spatial distribution of local aquatic organisms.

4. (D) It lacks sufficient sunlight for photosynthesis
The neritic zone comprises shallow marine waters overlying the continental shelf where sunlight easily penetrates the entire water column. This abundant solar energy, combined with nutrient runoff from land and coastal upwelling, fuels high rates of primary productivity, making it one of the most biologically diverse and productive regions in the ocean.

5. (B) Thermocline
The thermocline represents a distinct thermal transition layer in stratified bodies of water, such as lakes and oceans, where temperature decreases rapidly with depth. It effectively acts as a physical barrier separating the warmer, less dense surface water of the epilimnion from the colder, denser, and deeper water of the hypolimnion.

6. (C) Freshwater inflow exceeds evaporation rates
A positive estuary is characterized by freshwater inflow from rivers and rainfall exceeding seawater loss through evaporation. This hydrological balance results in a net seaward movement of low-salinity surface water, which is replaced by a deep inflow of high-salinity marine water, creating a highly stratified and ecologically dynamic salt wedge.

7. (D) Desiccation tolerance during low tides
Desiccation tolerance represents the primary physiological filter shaping the vertical zonation of benthic organisms along rocky intertidal shores. Organisms living in higher tidal zones must survive prolonged atmospheric exposure and drying wind during low tides, whereas those in lower zones remain submerged longer, shifting the limiting stress from physical tolerance to biological competition.

8. (B) 200 meters
The aphotic zone in marine environments begins at approximately two hundred meters depth, representing the boundary where sunlight becomes insufficient for photosynthesis. Below this depth, primary producers cannot survive, and the entire ecosystem relies on organic material sinking from the photic zone above, creating highly specialized communities adapted to darkness and high hydrostatic pressure.

9. (B) Estuarine ecosystems
Estuarine ecosystems exhibit extreme spatial and temporal variability in physical and chemical properties due to the dynamic collision of freshwater and seawater. Tidal cycles, seasonal river discharges, and weather events cause rapid fluctuations in salinity, temperature, turbidity, and nutrient concentrations, requiring resident organisms to possess highly specialized physiological adaptations to survive.

10. (A) I and II
In running water ecosystems, water velocity typically decreases from the steep gradient of

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2010
289. Fish Aggregating Devices (FADs) are utilized based on the behavioral tendency of pelagic fish to:
(A) Avoid any floating objects at sea
(B) Associate with floating objects in the open ocean for shelter, feeding, or spatial reference
(C) Migrate exclusively along the sea floor
(D) Bury themselves in benthic mud

2014
290. Drifting FADs (dFADs) are extensively used by commercial purse seine fleets primarily to target:
(A) Benthic flounders
(B) Deep-sea anglerfish
(C) Tropical tunas (e.g., Skipjack, Yellowfin)
(D) Intertidal crabs

2006
291. A significant ecological concern associated with the massive use of drifting FADs is the "ecological trap hypothesis," which suggests that FADs:
(A) Lure tunas into nutrient-poor waters
(B) Trap fish inside submerged netting
(C) Release toxins killing larval fish
(D) Hyper-oxygenate the surrounding water

2015
292. Moored FADs differ from drifting FADs in that moored FADs:
(A) Float freely with ocean currents
(B) Are anchored for localized fishing
(C) Are used in freshwater rivers only
(D) Never accumulate biofouling films

2003
293. The primary hydrodynamics consideration when designing a moored FAD is to ensure:
(A) Large ocean wave generation
(B) Anchor and mooring line integrity
(C) Movement against ocean currents
(D) High-tide sinking functionality

2021
294. A major issue contributing to bycatch in FAD-based purse seine fisheries is the un-intended capture of:
(A) Deep-sea corals
(B) Co-associated juveniles and sharks
(C) Benthic flatfish populations
(D) Freshwater dolphin species

2016
295. To mitigate bycatch, modern FAD designs emphasize:
(A) Increasing submerged net sizes
(B) Non-entangling biodegradable designs
(C) Bright lights for turtle attraction
(D) Toxic anti-fouling paint coatings

2005
296. FADs aggregate fish through several theorized mechanisms, one of which is the "indicator log hypothesis," proposing that:
(A) FADs allow rubbing off parasites
(B) Floating objects indicate rich waters
(C) Fish use FADs as spawning substrates
(D) FADs act as magnets for fish blood

2015
297. What is a "smart FAD" in commercial fisheries?
(A) FAD with predator evasion systems
(B) FAD with satellite biomass sensors
(C) FAD built from organic bamboo
(D) FAD that processes fish independently

2023
298. The aggregation of fish around a newly deployed FAD is a temporal process. Typically, which functional group arrives first?
(A) Large apex predators like marlin
(B) Small juvenile and forage fishes
(C) Benthic scavengers
(D) Marine mammals

2011
299. The "meeting point hypothesis" suggests that tunas associate with FADs because:
(A) FADs facilitate social schooling
(B) They block ocean current flows
(C) FADs provide unique ocean shade
(D) FADs emit natural acoustic signals

2007
300. The proliferation of lost and abandoned drifting FADs severely exacerbates which global marine issue?
(A) Eutrophication
(B) Ocean acidification
(C) Ghost fishing and marine plastic pollution
(D) Coral bleaching

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20. (B) II and IV
Estuaries generally exhibit much higher net primary productivity than open oceans due to land-derived nutrient inputs, while ocean upwelling enhances localized productivity by bringing deep nutrients to the surface. Light is not the sole limiting factor in marine systems, and carrying capacity estimates require diverse food web and habitat parameters beyond simple primary production.

21. (D) Error from microbial respiration overestimation
A primary limitation of the light and dark bottle oxygen technique is the potential error arising from microbial respiration overestimation within the enclosed bottles. Container effects, bacteria clinging to the glass, and changes in the microbial community during long incubations can inflate oxygen consumption, leading to inaccurate assessments of net primary productivity.

22. (B) Growth is limited by the scarcest resource
Liebig's Law of the Minimum states that the growth of an organism or population is controlled not by the total amount of resources available, but by the scarcest essential resource. In aquatic systems, primary production is often restricted by a single limiting nutrient like phosphorus or nitrogen, even if all other requirements are abundant.

23. (C) Increased organic loading and secondary productivity
An increase in biological oxygen demand indicates that a water body contains a high concentration of organic matter, which stimulates aerobic microbial decomposition. This elevated organic loading boosts heterotrophic microbial biomass and secondary productivity, but rapidly consumes dissolved oxygen, potentially creating hypoxic conditions that threaten fish and other oxygen-sensitive aquatic organisms.

24. (D) Limited influx of particulate organic matter
The most significant constraint on secondary productivity in deep-ocean benthic ecosystems is the extremely limited influx of particulate organic matter from the photic zone. Since photosynthesis cannot occur in the aphotic depths, benthic communities rely entirely on the sparse "marine snow" of falling organic debris, restricting overall biomass and energy transfer.

25. (B) $100 \frac{kcal}{m^2}$
According to ecological transfer principles, only about ten percent of the energy synthesized at one trophic level is transferred to the next. If primary producers generate ten thousand energy units, primary consumers receive one thousand units, leaving approximately one hundred energy units available to the secondary consumers at the third trophic level.

26. (B) Percent of ingested energy absorbed by gut
Assimilation efficiency is the percentage of food energy ingested by a consumer that is successfully absorbed across the gut wall into the body. This metric excludes energy lost as feces and varies significantly based on diet, with carnivorous species exhibiting much higher assimilation efficiency than herbivores due to the digestible nature of animal tissue.

27. (C) High phytoplankton turnover supporting biomass
Aquatic ecosystems often exhibit inverted biomass pyramids because the primary producers, mainly unicellular phytoplankton, have an exceptionally high turnover rate. Although their standing crop biomass is low at any given moment, their rapid reproduction and high productivity generate sufficient energy to support a larger biomass of long-lived, slow-growing zooplankton and fish.

28. (D) Originates from microbial processing of matter
A detritus food web in an aquatic ecosystem begins with dead organic matter instead of living primary producers. This dead material is colonized and broken down by decomposers like bacteria and fungi, which convert complex organic compounds into microbial biomass, subsequently providing an energy-rich food source for detritivorous invertebrates and higher trophic levels.

29. (A) Top-down control
Trophic cascades are classic examples of top-down control in aquatic food webs, where predators suppress the abundance or alter the behavior of their prey. This predator influence propagates downward through multiple lower trophic levels, ultimately affecting the abundance of primary producers, as seen when piscivores reduce planktivorous fish, allowing grazing zooplankton to bloom.

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110. (A) I and II
Coral reef degradation is driven by ocean acidification, which reduces carbonate ions needed for calcification, and thermal stress, which triggers coral bleaching as corals expel their symbiotic zooxanthellae. Degraded reefs exhibit lower structural complexity, which reduces fish biodiversity rather than supporting it, contradicting the claim that degraded reefs enhance biodiversity.

111. (A) Stabilize sediments and trap particulates
Seagrass beds are ecologically vital because their extensive root and rhizome systems stabilize coastal sediments and prevent erosion, while their dense leaf canopies slow water currents and trap suspended organic particulates. This filtration improves local water clarity and enhances light penetration, directly supporting other nearby ecosystems like coral reefs and mangrove forests.

112. (C) Decline in shrimp and reef fish
The cascading impact of mangrove deforestation on coastal fisheries manifests as a significant decline in shrimp and reef fish populations. Because many offshore and reef-associated species rely on mangrove estuaries as juvenile nursery habitats, losing these sheltered areas reduces recruitment success, ultimately causing a collapse in adult stocks harvested by commercial fisheries.

113. (D) Fleshy macroalgae
Coral reefs experiencing severe environmental stress, such as overfishing of herbivorous fish and nutrient pollution, often undergo a catastrophic phase shift. In this degraded state, the ecosystem transitions from a healthy, structurally complex environment dominated by calcifying corals to a simplified habitat dominated by fast-growing, fleshy macroalgae that inhibit coral larval settlement.

114. (D) Sequential habitat use by fish
Connectivity between mangroves, seagrass beds, and coral reefs refers to the sequential habitat use by fish and invertebrates during their life cycles. Many species spawn on coral reefs, drift to mangrove estuaries as larvae, migrate to seagrass beds as juveniles, and return to the reefs as adults, relying on the linked health of all three ecosystems.

115. (B) Shattering the limestone framework
Blast fishing degrades coral reefs by shattering the three-dimensional limestone framework built by calcifying corals over centuries. This destructive practice instantly kills all nearby marine organisms and reduces complex reef structures to barren rubble fields, eliminating the essential habitat niches, protective crevices, and spawning sites required to sustain diverse fish communities.

116. (D) Loss of refuge for juvenile fauna
Seagrass loss impacts coastal biodiversity primarily through the loss of essential refuge and foraging grounds for juvenile fauna. Without the dense leaf canopy of seagrass beds to hide in, young fishes and invertebrates are exposed to intense predation from larger piscivores, resulting in poor recruitment and a subsequent decline in offshore adult fish populations.

117. (A) Promoting epiphyte growth and shading
Eutrophication degrades seagrass beds by promoting the rapid growth of epiphytic algae on seagrass leaves and stimulating phytoplankton blooms in the water column. This excessive algal growth blocks sunlight from reaching the seagrass blades, severely reducing their photosynthetic capacity and leading to widespread die-offs of these vital nursery and sediment-stabilizing habitats.

118. (B) The future extinction of species due to events that occurred in the past
Extinction debt refers to the future, inevitable extinction of species due to habitat destruction or degradation events that occurred in the past. Although some species persist in fragmented habitats for generations following the initial disturbance, their populations are no longer viable, representing a delayed ecological toll that will manifest over time.

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119. (D) Impairing olfactory discrimination
Ocean acidification impacts the sensory ecology of reef fish by impairing their olfactory discrimination and neurological processing. Elevated carbon dioxide levels alter neurotransmitter function in the fish brain, preventing larvae from recognizing chemical cues used to locate suitable reef habitats, find food, and detect the scent of approaching predators, severely reducing their survival.

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40. (A) Both A and R are true and R is the correct explanation of A.
A species' fundamental niche encompasses all environmental conditions it can physically tolerate, but biological constraints like interspecific competition and predation restrict the species to a narrower realized niche. Therefore, the actual space and resources an organism exploits in nature are smaller than its physiological potential, making both statements true and logically linked.

41. (B) Utilizing different resources or habitats within the same ecosystem
Resource partitioning enables sympatric species to avoid competitive exclusion by dividing limited resources or utilizing distinct spatial and temporal microhabitats within the same ecosystem. By specializing in different prey sizes, foraging depths, or feeding times, coexisting species reduce direct competition, allowing them to occupy stable, non-overlapping realized niches.

42. (C) Predator-prey dynamics and interspecific competition
The Lotka-Volterra equations are classical mathematical models used in ecology to describe and predict the population dynamics of interacting species, specifically predator-prey relationships and interspecific competition. These differential equations simulate how the growth rate of one population is influenced by the density of another, producing characteristic oscillations over time.

43. (D) Nitrogen-15 ($\delta^{15}N$) enrichment
Stable nitrogen isotope analysis relies on the predictable enrichment of nitrogen-15 relative to nitrogen-14 up the food chain. Because consumers preferentially excrete the lighter isotope, their tissues become progressively enriched by three to four per mil at each consecutive trophic level, providing an accurate, continuous measure of an organism's long-term trophic position.

44. (C) Interspecific competition
Character displacement is an evolutionary process where sympatric, closely related species evolve pronounced morphological differences in traits related to resource acquisition. This divergence is driven by intense interspecific competition for limiting resources, which favors individuals that exhibit non-overlapping traits, thereby facilitating resource partitioning and reducing competitive pressures over generations.

45. (B) Exerting high influence relative to abundance
A keystone species is an organism that exerts a disproportionately large influence on the structure and function of its ecological community relative to its actual abundance or biomass. The removal of such a species can trigger dramatic trophic cascades, leading to reduced biodiversity and a complete restructuring of the entire ecosystem.

46. (B) Ontogenetic niche shift
An ontogenetic niche shift occurs when an organism undergoes a distinct change in its habitat use, resource consumption, or trophic level as it grows and matures. This transition is common in fish species that shift from feeding on tiny zooplankton as larvae to preying on larger invertebrates and fishes as adults.

47. (D) Coevolution
Coevolution describes the reciprocal evolutionary process where two or more species exert strong selective pressures on one another, driving adaptive changes over time. In competitive or predator-prey relationships, a modification in one species' resource acquisition traits or defense mechanisms triggers a corresponding evolutionary response in the interacting species to maintain fitness.

48. (B) Primary producers are strictly assigned a trophic index of zero
In trophodynamic modeling, primary autotrophic producers that synthesize organic matter from sunlight or chemical energy are strictly assigned a baseline trophic index of one, not zero. Consumers are then positioned at higher, often fractional values, with herbivores at level two and omnivores occupying intermediate, non-integer values depending on their dietary composition.

49. (B) Benthic crab larvae settling after maturation
Meroplankton are organisms that spend only a portion of their life cycle as plankton in the water column before transitioning to a benthic or nektonic existence. An example is the larval stage of benthic crabs, which drift in the ocean currents to disperse before settling onto the seafloor to mature.

50. (A) P-3, Q-4, R-1, S-2
Aquatic organisms are classified into functional groups based on habitat: neuston inhabit

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70. (A) II, III, I
Aquatic macroinvertebrates vary in their tolerance to organic pollution, with stoneflies being highly sensitive and requiring clean, well-oxygenated water. Isopod slaters exhibit moderate tolerance, surviving in mildly degraded conditions, while midge larvae are extremely tolerant, often dominating heavily polluted and hypoxic sediments where other organisms cannot survive.

71. (A) Are highly sensitive to pollution
The Biological Monitoring Working Party score system assesses river water quality by assigning high scores to macroinvertebrate taxa that are highly sensitive to organic pollution, such as stonefly and mayfly families. Conversely, tolerant taxa like bloodworms receive low scores, and the cumulative score of the sampled families indicates the overall biological health of the stream.

72. (D) Inhibition of acetylcholinesterase (AChE) activity
In fish, the inhibition of acetylcholinesterase enzyme activity in brain and muscle tissue is a specific biomarker for exposure to neurotoxic organophosphate and carbamate pesticides. This inhibition prevents the breakdown of the neurotransmitter acetylcholine, leading to continuous nerve firing, muscle paralysis, and eventual respiratory failure in affected aquatic organisms.

73. (D) Organism to surrounding water levels
The bioconcentration factor is a dimensionless ratio that quantifies the concentration of a chemical in an aquatic organism relative to its concentration in the surrounding water. This metric assumes the chemical is absorbed solely through respiratory surfaces like gills or dermal contact, excluding dietary intake, under steady-state conditions in a laboratory setting.

74. (C) Both water and dietary sources
Bioaccumulation is the cumulative process by which an organism absorbs a toxicant from all environmental sources, including water, sediment, and dietary intake, faster than it can be excreted or metabolized. This differs from bioconcentration, which strictly describes toxicant absorption from the water alone, representing a more comprehensive measure of exposure in natural ecosystems.

75. (A) Lipophilic and resistant to metabolic degradation
Biomagnification occurs with pollutants that are highly lipophilic and resistant to physical or biological degradation. Because these substances dissolve easily in lipids and cannot be metabolized, they accumulate within the fatty tissues of organisms and are transferred with high efficiency up the food web, resulting in progressively higher concentrations at successive trophic levels.

76. (B) Bioconcentration
The octanol-water partition coefficient is a physical chemical property used to predict an organic compound's lipophilicity and its potential for bioconcentration in aquatic organisms. A high coefficient value indicates the substance is hydrophobic and lipophilic, meaning it will partition easily into the lipid-rich tissues of organisms rather than remaining dissolved in water.

77. (D) The chemical concentration increases from prey to predator
A biomagnification factor greater than one indicates that the concentration of a chemical contaminant increases from prey to predator across adjacent trophic levels. This trophic transfer occurs because the predator ingests contaminated prey over its lifetime, assimilating and storing the non-metabolizable, lipophilic chemical in its body tissues at concentrations exceeding those of its food.

78. (A) Methylmercury
Methylmercury is a classic organic pollutant known for undergoing severe biomagnification in aquatic food webs. Because it is highly lipid-soluble and binds strongly to proteins in animal tissue, it is absorbed with high efficiency and excreted slowly, leading to dangerous concentrations in top predators like tuna, swordfish, and piscivorous birds.

79. (D) Uptake and elimination rates
The dynamic model of bioaccumulation estimates the net internal concentration of a toxicant in an aquatic organism over time based on the mathematical balance between uptake and elimination rates. This kinetic approach considers multiple pathways of chemical entry, such as gills and diet, alongside metabolic

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to two hundred micrometers, while mesoplankton are larger, representing a standardized scale used by oceanographers to study plankton community structure and ecology.

61. (A) Reflect cumulative environmental stress over time
Aquatic bioindicators are organisms utilized in environmental monitoring because their physiological health, abundance, or behavioral responses reflect the cumulative effects of multiple environmental stressors over time. Unlike discrete chemical water samples that provide only instantaneous measurements, these biological monitors integrate long-term exposures, offering a highly realistic assessment of ecosystem health.

62. (A) Ephemeroptera, Plecoptera, Trichoptera
The EPT index is a widely used freshwater biotic index that calculates the cumulative richness of three pollution-sensitive aquatic insect orders: Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). Because these taxa are highly intolerant to dissolved oxygen depletion and organic pollutants, their presence and diversity indicate healthy, clean aquatic habitats.

63. (B) Excellent water quality and high dissolved oxygen
A high EPT index value in a freshwater stream indicates excellent water quality, characterized by high dissolved oxygen levels and minimal chemical or organic pollution. Since mayflies, stoneflies, and caddisflies are highly sensitive to environmental degradation, their diverse and abundant populations signify a stable, healthy, and relatively undisturbed aquatic habitat.

64. (D) They are highly mobile and migrate quickly from polluted areas
Benthic macroinvertebrates are valuable bioindicators primarily because of their sedentary or limited mobility lifestyles, which prevent them from escaping localized pollution events. Consequently, changes in their community structure directly reflect the chemical and physical quality of their immediate habitat, making them ideal for monitoring chronic, localized environmental stressors.

65. (B) Severe organic pollution and hypoxia
Dense populations of Tubifex worms, often called sludge worms, are classic indicators of severe organic pollution and hypoxic conditions in freshwater ecosystems. These organisms possess high concentrations of hemoglobin, allowing them to survive in extremely low-oxygen environments where more sensitive taxa, such as mayfly or stonefly larvae, cannot persist.

66. (A) Escherichia coli
Escherichia coli is a bacterium widely utilized as a standard bioindicator for fecal contamination in aquatic environments. Since it resides in the intestinal tracts of warm-blooded animals, its presence in water samples indicates recent sewage pollution, warning of potential pathogens that pose significant health risks to humans and aquatic organisms.

67. (B) Index of Biological Integrity (IBI)
The Index of Biological Integrity is a multi-metric scientific tool used to evaluate the ecological health of a water body by comparing its species composition and community structure against a pristine, unimpacted reference site. It integrates various ecological attributes, such as species richness, trophic composition, and individual health, to quantify human-induced degradation.

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68. (B) Physiological sub-organismal level alterations
Biomarkers in aquatic bioindicators refer to measurable physiological, biochemical, or cellular alterations within an organism that indicate exposure to environmental contaminants or stressors. These sub-organismal changes, such as enzyme inhibition or cellular stress protein synthesis, serve as early warning signals of ecological damage long before effects manifest at the population level.

69. (B) Filter feeding results in bioaccumulation
Bivalve mollusks are globally utilized in "Mussel Watch" programs because their sessile nature and filter-feeding behavior cause them to bioaccumulate waterborne contaminants. By continuously filtering large volumes of water, they concentrate heavy metals, petroleum hydrocarbons, and synthetic organic pollutants in their tissues, providing an integrated record of localized coastal pollution.

30. (B) III and V
Pyramids of energy represent the total energy flowing through each trophic level and can never be inverted due to thermodynamics. Additionally, metabolic respiration losses actually increase at higher trophic levels as active predators expend more energy searching for prey, making the statements about inverted energy pyramids and decreasing respiration losses completely incorrect.

31. (D) Incomplete digestion and metabolic heat loss
Low ecological transfer efficiency between trophic levels is primarily driven by energy lost as metabolic heat during respiration, excretion, and incomplete digestion of consumed biomass. Organisms consume energy for maintenance, locomotion, and biochemical synthesis, meaning only a fraction of the ingested energy is actually converted into new tissue available for consumption by predators.

32. (D) Fourth trophic level
In this marine food chain, phytoplankton represent the primary producers at the first trophic level, while zooplankton act as primary consumers at the second level. Planktivorous fish feeding on zooplankton occupy the third trophic level, placing the piscivorous fish that prey on them squarely in the fourth trophic level of the system.

33. (A) Ecological transfer efficiency
Ecological transfer efficiency is the parameter used to quantify the overall efficiency of energy transfer between adjacent trophic levels in a food web. It is calculated as the ratio of energy flow or production at a higher trophic level to that of the next lower level, reflecting cumulative consumption, assimilation, and production efficiencies.

34. (C) Diatoms - Copepods
Diatoms are unicellular photosynthetic algae that serve as vital primary producers in marine and freshwater ecosystems, while copepods are small, abundant zooplankton that feed directly upon them. This relationship represents a classic primary producer and primary consumer link that underpins pelagic food webs, transferring solar-derived energy to higher trophic levels like fish.

35. (D) Interconnected nature of multiple food chains
The fundamental distinction between a food chain and a food web lies in their complexity; a food chain represents a linear pathway of energy flow from a single producer to an apex predator, whereas a food web is an interconnected network of multiple food chains, accurately reflecting the diverse feeding relationships in nature.

36. (B) Their lack of thermoregulation costs (ectothermy)
Aquatic invertebrates exhibit much higher production efficiency than vertebrates because they are ectothermic, meaning they do not expend metabolic energy to regulate internal body temperature. Without the high energetic costs of thermoregulation, these invertebrates can channel a significantly larger portion of their assimilated energy directly into somatic growth and reproductive biomass.

37. (D) Full range of survivable environmental conditions
The fundamental niche of a species represents the entire range of environmental conditions, such as temperature, salinity, and resource availability, under which it can survive and reproduce. This concept is purely physiological and assumes the complete absence of interspecific competition, predation, and other negative biological interactions that restrict actual distribution.

38. (B) Species sharing a limiting resource cannot coexist
Gause's principle of competitive exclusion states that two species competing for the exact same limiting resource cannot stably coexist if all other ecological factors remain constant. The species with even a slight advantage will eventually outcompete and displace the other, forcing the subordinate species to adapt, shift its niche, or face local extinction.

39. (A) Dietary composition and prey trophic levels
Mathematical modeling of a consumer's trophic index in aquatic ecosystems relies heavily on quantitative data describing its dietary composition and the trophic levels of its prey. By analyzing stomach contents or chemical biomarkers, researchers can calculate a weighted average that reflects the exact position of the species within the broader food web.

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biotransformation, fecal excretion, and growth dilution processes.

80. (D) $K_{\{ow\}}$ - Measure of chemical toxicity to enzymes
The octanol-water partition coefficient is a physical-chemical property representing a substance's lipid solubility and hydrophobic partitioning behavior, not a measure of chemical toxicity to enzymes. The other terms are correctly defined: bioconcentration refers to water-only uptake, bioaccumulation spans all sources, and biomagnification measures toxicant transfer across consecutive trophic levels.

81. (B) Decreases concentration via volume expansion
Growth dilution occurs when an aquatic organism experiences rapid somatic growth, increasing its overall body mass and tissue volume faster than it accumulates a specific toxicant. Although the total body burden of the chemical remains constant, its concentration per unit of tissue decreases, potentially masking the true extent of bioaccumulation in young organisms.

82. (A) Higher bioaccumulation factors
For lipophilic organic pollutants, aquatic organisms with higher lipid contents will generally exhibit higher bioaccumulation factors. This is because these hydrophobic chemicals partition preferentially into lipids, allowing fat-rich species or individuals to accumulate and store larger quantities of the toxicant within their adipose tissues before reaching thermodynamic equilibrium with the environment.

83. (D) Dioxins and dioxin-like PCBs
The toxic equivalent approach is a regulatory method used to assess the cumulative risk of mixtures of complex biomagnifying compounds like dioxins, furans, and dioxin-like PCBs. This technique scales the concentration of individual congeners based on their toxicity relative to the most toxic congener, providing a single standardized value for environmental safety assessments.

84. (B) Anaerobic bacterial methylation activity
The transformation of inorganic mercury to highly bioavailable and toxic methylmercury is primarily driven by anaerobic bacterial methylation activity in aquatic sediments. Sulfate-reducing and iron-reducing bacteria operating in anoxic conditions convert mercury as a byproduct of their metabolic processes, facilitating its entry and subsequent biomagnification up the aquatic food web.

85. (B) Disturbance magnitude before state shift
Ecological resilience is defined as the magnitude of disturbance an aquatic ecosystem can absorb before its organizational structure and functional processes shift into an alternative stable state. This concept focuses on the capacity of a system to maintain its core identity, feedback loops, and species interactions despite facing significant external perturbations.

86. (C) Internal stability despite external changes
Ecological homeostasis in aquatic environments refers to the capacity of an ecosystem to maintain internal stability and chemical balance despite facing external environmental changes. This self-regulating capability is maintained through complex physical, chemical, and biological feedback loops, allowing the system to buffer external perturbations and preserve its structural and functional integrity.

87. (A) Engineering resilience (stability)
Engineering resilience refers to the speed and efficiency with which a disturbed aquatic ecosystem returns to its original, pre-disturbance equilibrium state. This metric focuses on stability near a single steady state, quantifying the time required for physical and biological variables to recover following a transient perturbation, such as a localized flood or chemical spill.

88. (D) Disturbance causes persistent structural shifts
The concept of alternative stable states implies that an aquatic ecosystem can exist under different, self-reinforcing configurations of species and environmental conditions. If a significant disturbance pushes the system past a critical threshold, it can trigger a persistent structural shift into a different state that is maintained by new ecological feedbacks.

89. (B) A catastrophic regime shift
A shallow lake shifting from a clear-water state dominated by submerged plants to a turbid state dominated by phytoplankton represents a classic catastrophic regime shift. This abrupt transition occurs when nutrient enrichment or physical disturbance exceeds a threshold, breaking down

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the air-water interface, while nekton swim actively against currents. Periphyton consist of microscopic organisms attached to submerged surfaces, whereas benthos reside on or within bottom sediments, representing a diverse array of organisms adapted to living on the seafloor.

51. (A) Sequestration of carbon via the biological pump
Phytoplankton play a critical role in global biogeochemical cycles by fixing dissolved inorganic carbon through photosynthesis in the photic zone. When these organisms die or are consumed, a portion of this organic carbon sinks into the deep ocean, driving the biological pump and sequestering atmospheric carbon dioxide for centuries.

52. (B) Remain planktonic for their entire life cycle
Holoplankton are distinguished from meroplankton by remaining planktonic throughout their entire life cycle, from egg to adult. These organisms, which include copepods, chaetognaths, and many diatoms, live exclusively in the water column, whereas meroplankton spend only their early developmental or larval stages drifting before settling into benthic or nektonic lifestyles.

53. (C) Megaplankton
Benthic organisms are classified into distinct size categories: microbenthos are microscopic, meiobenthos pass through coarse screens but are retained on fine meshes, and macrobenthos are visible to the naked eye. Megaplankton, however, is a size-based classification for pelagic planktonic organisms rather than benthic fauna, making it the exception.

54. (A) Diatoms
Diatoms are unicaceous phytoplankton characterized by unique cell walls made of silica, known as frustules. When these organisms die, their heavy silica shells sink to the ocean floor and accumulate in vast quantities, eventually forming thick deposits of siliceous oozes, which serve as crucial indicators of past climate and ocean productivity.

55. (B) Benthic organisms
Epifauna and infauna are two major sub-classifications of benthic organisms. Epifauna live on the surface of marine or freshwater sediments, rocks, and shells, while infauna burrow into or live within the soft sediment matrix itself, representing distinct ecological strategies for feeding and avoiding predators on the aquatic seafloor.

56. (C) Active transport of carbon to deeper ocean layers
Diel vertical migration of zooplankton involves swimming up to food-rich surface waters at night to feed and returning to cold, dark depths during the day to avoid visual predators. This massive biological movement drives the active transport of organic carbon and nutrients to deeper ocean layers, accelerating the biological carbon pump.

57. (D) Copepods
Copepods are tiny, abundant crustaceans that constitute the dominant component of marine zooplankton, often representing the primary link between phytoplankton and higher trophic levels. As highly efficient grazers, they serve as the most abundant secondary consumers in the global ocean, transferring vital energy and essential lipids to larval and adult fishes.

58. (B) Infaunal macrobenthos
Bioturbation is the physical disruption and mixing of aquatic sediments by living organisms, primarily driven by infaunal macrobenthos like burrowing worms, bivalves, and crustaceans. Their feeding, burrowing, and irrigation activities alter sediment structure, enhance oxygen penetration, and accelerate the exchange of dissolved nutrients between the sediment and overlying water column.

59. (B) Nitrogen fixation
Cyanobacteria play a vital role in the aquatic nitrogen cycle by performing nitrogen fixation, a biochemical process that converts inert dissolved dinitrogen gas into bioavailable ammonium. Specialized species utilize thick-walled cells called heterocysts to protect the oxygen-sensitive nitrogenase enzyme, supplying essential nitrogen that stimulates primary productivity in nutrient-limited waters.

60. (A) Picoplankton, Nanoplankton, Microplankton, Mesoplankton
Plankton are categorized into size classes based on logarithmic dimensions: picoplankton are the smallest at under two micrometers, followed by nanoplankton measuring up to twenty micrometers. Microplankton range from twenty

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surface layers to exploit thin zones of atmospheric oxygen diffusion.

100. (A) P-3, Q-4, R-1, S-2
Different aquatic pollutants have specific impacts: thermal pollution reduces oxygen solubility while boosting fish metabolism, and agricultural runoff acts as a diffuse source of nutrients. Acid mine drainage dramatically lowers water pH, mobilizing toxic heavy metals, while oil spills physically coat fish gills, severely restricting oxygen diffusion and causing rapid asphyxiation.

101. (B) Nocturnal oxygen depletion and decay
Eutrophication causes catastrophic fish kills primarily through nocturnal oxygen depletion and the microbial decay of massive algal blooms. During the night, photosynthesis stops but both algae and microbes continue to respire, rapidly consuming dissolved oxygen, while the decomposition of dead algae by aerobic bacteria further drives oxygen levels down to lethal levels.

102. (C) Urban stormwater surface runoff
Non-point source pollution originates from diffuse, poorly defined land areas rather than a single, discrete discharge pipe. An example is urban stormwater surface runoff, which accumulates pollutants like oil, heavy metals, and litter across roads and parking lots before draining into local water bodies, making it challenging to regulate and treat.

103. (B) Increases
Ammonia toxicity in aquatic ecosystems is highly dependent on water pH and temperature. As pH increases, the chemical equilibrium shifts, significantly increasing the proportion of toxic, unionized ammonia relative to the non-toxic, ionized ammonium form. This unionized molecule easily penetrates fish gill membranes, disrupting internal cellular biochemistry and causing severe physiological damage.

104. (D) Feminization of male fish species
Endocrine-disrupting chemicals in aquatic environments most commonly cause the feminization of male fish populations. These synthetic pollutants, which include plasticizers and pharmaceuticals, mimic natural estrogens, triggering the abnormal synthesis of vitellogenin, an egg-yolk precursor protein normally produced only by females, and inducing the development of testicular oocytes in males.

105. (B) Nutrient-induced bottom-water hypoxia
Aquatic dead zones are primarily caused by nutrient-induced bottom-water hypoxia, where agricultural runoff carrying fertilizers fuels massive phytoplankton blooms. When these algae die and sink to the ocean floor, their decomposition by aerobic bacteria consumes nearly all dissolved oxygen, creating vast hypoxic zones where sessile benthic organisms perish and mobile fish are forced to flee.

106. (B) 5 days at $20^{\circ}C$
The standard biochemical oxygen demand test measures the amount of dissolved oxygen consumed by aerobic microorganisms as they decompose organic matter in a water sample over five days at twenty degrees Celsius. This standardized protocol is widely used to quantify the organic pollution load of wastewater and its potential to deplete oxygen in receiving waters.

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107. (D) Cadmium
Cadmium is a heavy metal pollutant that causes severe physiological disruption in freshwater fish by competing directly with calcium ions for uptake at the calcium channels on gill surfaces. This competitive inhibition impairs the fish's ability to maintain calcium homeostasis, leading to hypocalcemia, skeletal deformities, neurological dysfunction, and eventual mortality.

108. (B) Smothering grounds and gill damage
Excessive suspended solids and high turbidity impact fisheries resources by physically damaging fish gills and smothering benthic spawning grounds. Suspended sediment particles abrade delicate gill membranes, inducing mucus hypersecretion and clogging respiratory surfaces, while settling silt covers gravel nests, effectively suffocating developing fish eggs and significantly reducing larval survival rates.

109. (B) Sheltered nursery habitats with food
Mangroves provide critical support for fish recruitment by functioning as sheltered nursery habitats with rich food resources. The complex, underwater root architecture of mangrove trees dampens wave energy, creating a calm sanctuary that protects post-larval and juvenile fishes from large marine predators while providing abundant detritus-based food to fuel rapid growth.

existing stabilizing feedbacks and establishing new, highly stable turbid-water dynamics.

90. (A) Both A and R are true and R is the correct explanation of A.
High biodiversity enhances the ecological resilience of an aquatic ecosystem because diverse communities exhibit high functional redundancy. This means that multiple species perform similar ecological roles, ensuring that if one species is lost due to a disturbance, others can step in to maintain critical ecosystem processes and prevent a regime shift.

91. (B) Hysteresis
Hysteresis is the ecological phenomenon where the pathway of ecosystem recovery from a degraded state differs significantly from the pathway of its original degradation. This means that simply reversing the stressor to its previous levels is often insufficient to restore the system, requiring much larger remedial actions to overcome the new state's feedback loops.

92. (A) The ability of a system to withstand disturbance without changing its state
Resistance in ecological stability refers to the ability of an aquatic ecosystem to withstand external disturbances and pressures without undergoing a change in its structural or functional state. Highly resistant systems possess natural buffering mechanisms, such as physical structures or species tolerances, that prevent perturbations from altering their baseline ecological dynamics.

93. (A) Dominance by a single keystone
Dominance by a single keystone species can decrease the overall stability of an aquatic food web by creating a single point of failure. If this critical species is lost or suppressed due to environmental stress, the entire network of feeding links can collapse, triggering extreme trophic cascades and reducing community resilience.

94. (B) Intermediate disturbance hypothesis
The intermediate disturbance hypothesis suggests that local species diversity in an aquatic ecosystem is maximized when ecological disturbances are neither too frequent nor too rare. At intermediate levels of disturbance, colonization by pioneering species and competitive exclusion by dominant species are balanced, allowing a wide variety of taxa to coexist.

95. (B) The range of conditions within which a system tends to return to a specific equilibrium state
In ecological stability modeling, the basin of attraction represents the range of environmental states and population densities within which an aquatic ecosystem can fluctuate and still return to its specific equilibrium. If a disturbance pushes the system beyond the boundaries of this basin, it enters a different state's basin.

96. (D) Abrupt transitions to contrasting states
Tipping points in aquatic ecosystems are critical thresholds where small, incremental changes in an environmental driver can trigger sudden, dramatic, and often irreversible transitions to contrasting ecological states. These abrupt shifts occur when negative feedback loops that maintain the original state are overwhelmed, allowing positive feedback loops to rapidly establish a new equilibrium.

97. (D) Discharge from a discrete, identifiable pipe, outfall, or ditch
Point source aquatic pollution is defined as contamination that originates from a single, discrete, and easily identifiable conveyance, such as a factory discharge pipe, a sewage outfall, or a municipal ditch. Because these sources have specific locations, they are generally easier to monitor, regulate, and treat compared to diffuse runoff.

98. (A) Nitrogen and phosphorus
Cultural eutrophication is primarily driven by anthropogenic inputs of nitrogen and phosphorus entering aquatic ecosystems from agricultural runoff, sewage discharge, and industrial waste. These excess nutrients over-stimulate the growth of phytoplankton and macroalgae, triggering harmful algal blooms that deplete dissolved oxygen, reduce water clarity, and severely degrade local aquatic habitats.

99. (B) Reduced growth rates and altered swimming behavior
In fish exposed to severe hypoxia from eutrophication, typical physiological impacts include reduced somatic growth rates and altered swimming behavior. Because oxygen is limited, fish must restrict energy-intensive activities, shifting their metabolism to anaerobic pathways, altering ventilation rates, and swimming to

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120. (B) I, II, and IV
Coastal development drives mangrove loss, coral reefs support immense biodiversity despite their small area, and habitat complexity is positively correlated with species richness. Conversely, seagrasses are highly vulnerable to bottom trawling, which physically uproots plants and destroys the seabed, making the third statement incorrect and the other three correct.

121. (B) Right in the Northern Hemisphere and left in the Southern Hemisphere
The Coriolis effect, caused by the rotation of the Earth on its axis, deflects moving water masses and air currents. This force deflects trajectories to the right of the direction of motion in the Northern Hemisphere and to the left in the Southern Hemisphere, shaping global wind patterns and major ocean currents.

122. (C) 90 degrees to the right of the wind direction
Ekman transport causes the net movement of surface water in the Northern Hemisphere to be oriented ninety degrees to the right of the prevailing wind direction. This phenomenon occurs as wind energy is transferred down the water column, with each successive layer deflecting further right due to the Coriolis effect, producing a net transport perpendicular to the wind.

123. (A) Earth, Moon, and Sun align
Spring tides, which feature the maximum tidal range with high high tides and low low tides, occur when the Earth, Moon, and Sun align during the full moon and new moon phases. This alignment combines the gravitational pull of the Sun and Moon, maximizing the tidal bulge experienced on Earth.

124. (B) Planetary wind systems and the Coriolis effect
Major global ocean gyres are large circular systems of rotating currents driven primarily by planetary wind systems, such as the trade winds and westerlies, combined with the Coriolis effect. The winds push surface waters, while the Coriolis force deflects the currents, creating massive clockwise rotations in the Northern Hemisphere and counterclockwise rotations in the Southern Hemisphere.

125. (B) Wavelength
In deep water, the speed of a wind-generated ocean wave is determined solely by its wavelength or wave period. Because deep-water waves do not interact with the seafloor, their propagation speed increases with longer wavelengths, allowing long-period swell waves to travel faster across open ocean basins than short-period, wind-driven waves.

126. (B) Bottom friction slows wave bases
A wave breaks as it approaches the shore because bottom friction slows the base of the wave as it enters shallow water. While the wave base decelerates, the wave crest continues moving forward at its original speed, causing the wave height to increase and the crest to eventually become unstable and tumble forward.

127. (B) Temperature and salinity
Thermohaline circulation is the deep, global ocean circulation pattern driven by water density gradients, which are determined by temperature and salinity differences. Colder, saltier water is denser and sinks at polar regions, while warmer, less dense water flows along the surface to replace it, creating a global ocean conveyor belt that regulates climate.

128. (B) First quarter and third quarter moons
Neap tides occur during the first and third quarter lunar phases when the gravitational pulls of the Moon and Sun are at right angles to each other relative to Earth. This opposing geometry partially cancels out their gravitational forces, resulting in the minimum tidal range with low high tides and high low tides.

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129. (B) Narrow, deep, and fast-moving
Western boundary currents, which flow along the western edges of subtropical gyres, are typically narrow, deep, and fast-moving. Driven by western intensification, a phenomenon caused by the Earth's rotation and the variation of the Coriolis effect with latitude, these currents transport warm equatorial waters toward the poles, influencing coastal climates and marine ecosystems.

130. (B) III and IV
The Coriolis effect is actually weakest at the equator, where its value is zero, and strongest at the poles. Additionally, tidal cycles are determined by the combined gravitational pull

whereas specialized halophilic bacteria can efficiently degrade organic compounds, remove excess nitrogen, and reduce suspended solids under these elevated salt concentrations.

213. (D) Plant roots absorb toxic metals
Rhizofiltration is a phytoremediation technique where plant roots are used to absorb, concentrate, and precipitate toxic heavy metals and organic pollutants from contaminated aquatic systems. As water flows through the root zone, the plants integrate these contaminants in their root tissue or adsorb them onto root surfaces, cleaning the surrounding water.

214. (B) Dissolved oxygen
The effectiveness of aerobic microbial degradation of organic pollutants in water is strongly limited by the availability of dissolved oxygen. Aerobic bacteria require oxygen as a terminal electron acceptor to metabolize organic contaminants; if oxygen is depleted, biodegradation slows significantly as the system shifts to slower anaerobic metabolic pathways.

215. (A) Adding fertilizers (N and P) to biostimulate indigenous hydrocarbon-degrading bacteria
Following a marine oil spill, a common bioremediation strategy is the addition of nitrogen and phosphorus fertilizers to biostimulate native hydrocarbon-degrading bacteria. While oil provides an abundant carbon source, microbial growth is limited by nutrient availability; adding fertilizers accelerates the bacteria's natural capacity to break down the toxic petroleum hydrocarbons.

216. (B) High cost and logistical difficulties associated with dredging and transportation
A significant drawback of ex-situ bioremediation of contaminated aquatic sediments is the high cost and logistical complexity associated with dredging and transporting the toxic material. Dredging also risks resuspending buried contaminants and destroying benthic habitats, making this approach much more disruptive and expensive than treating the pollution in-situ.

217. (D) Altering the food web structure to reduce phytoplankton biomass
Ecological biomanipulation for restoring eutrophic lakes fundamentally relies on deliberately altering the food web structure to reduce phytoplankton biomass and improve water clarity. By shifting the abundance and composition of fish species, biomanipulation aims to enhance grazing pressure on algae, steering the lake toward a stable, clear-water state.

218. (B) Stocking piscivores to boost grazers
A classic top-down biomanipulation strategy to control algal blooms involves stocking piscivorous fish, such as pike or bass, to suppress planktivorous fish populations. Reducing these planktivores decreases predation pressure on large, herbivorous zooplankton like Daphnia, allowing the zooplankton to bloom and exert intense grazing pressure on the nuisance phytoplankton.

219. (A) Reducing external and internal nutrient loading (e.g., phosphorus reduction)
Bottom-up control of a eutrophic water body focuses on reducing external and internal nutrient loading, particularly phosphorus. By restricting the essential raw materials required for algal growth, this management approach directly limits phytoplankton carrying capacity, helping to restore water quality and prevent harmful algal blooms without manipulating the food web.

220. (A) I, II, and IV
In biomanipulation, increasing piscivores reduces planktivores, which in turn allows grazing zooplankton to increase. This intervention is a clear application of the top-down control model; however, an increase in large zooplankton reduces phytoplankton biomass through grazing, making the third statement incorrect and the other three statements correct.

221. (B) Daphnia (Cladocera)
Daphnia are large, filter-feeding cladoceran zooplankton that represent the most effective grazers targeted for enhancement during lake biomanipulation. Because of their large size and efficient feeding appendages, they can filter massive volumes of water, consuming wide size ranges of phytoplankton and rapidly clearing turbid waters when protected from fish predation.

222. (B) They are toxic and poorly nutritious
Cyanobacteria are notoriously difficult to control via traditional biomanipulation because they are highly toxic to zooplankton and possess poor nutritional value. Many species also form large

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wind-driven currents push nutrient-poor surface waters downward, the photic zone remains depleted of essential nutrients, limiting phytoplankton growth and resulting in simplified, less productive food webs compared to nutrient-rich upwelling systems.

142. (B) Carbon transport via sinking matter
The biological pump in upwelling and marine systems refers to the process by which atmospheric carbon dioxide is fixed by phytoplankton via photosynthesis, transferred through the food web, and transported to the deep ocean as sinking organic matter, including dead cells, fecal pellets, and marine snow, sequestering carbon on geological timescales.

143. (B) The Southwest Monsoon
The Somali coast upwelling in the western Indian Ocean is driven by the strong winds of the Southwest Monsoon during the summer. These intense winds blow parallel to the coastline, forcing surface waters offshore via Ekman transport and drawing up cold, nutrient-rich subsurface waters that stimulate massive plankton blooms and pelagic fish aggregations.

144. (A) Dissolved silicates and nitrates
High biological productivity in upwelling areas is reflected by high surface concentrations of dissolved nutrients like silicates and nitrates. These essential chemicals, which accumulate in the deep ocean through organic decomposition, are brought to the sunlit surface layers by upwelling currents, providing the necessary raw materials for massive diatom and phytoplankton blooms.

145. (A) Warm temperatures in eastern Pacific
The El Niño phase of the El Niño-Southern Oscillation is characterized by unusually warm sea surface temperatures in the central and eastern equatorial Pacific Ocean. This warming occurs when the prevailing trade winds weaken, allowing a warm pool of western Pacific water to slide eastward, suppressing the cold Humboldt Current upwelling off South America.

146. (B) Suppresses nutrient-rich upwelling
El Niño severely impacts the Peruvian Anchoveta fishery by suppressing the nutrient-rich coastal upwelling system. The eastward shift of warm water deepens the thermocline, meaning that the wind-driven upwelling currents can only lift warm, nutrient-poor surface water. This starves the phytoplankton, causing a collapse in the anchoveta population and associated fisheries.

147. (B) Enhanced eastern Pacific productivity
La Niña represents the cool phase of the ENSO cycle, characterized by stronger-than-normal trade winds that push warm water westward. This intensifies the upwelling of cold, nutrient-rich deep water along the eastern Pacific, resulting in lower sea surface temperatures and enhanced primary productivity, which supports abundant pelagic fish populations in the region.

148. (B) Indian Ocean Dipole (IOD)
The Indian Ocean Dipole is a coupled ocean-atmosphere phenomenon in the Indian Ocean, analogous to the Pacific ENSO, that heavily influences regional climate and marine fisheries. It is characterized by an irregular oscillation of sea surface temperatures between the western and eastern parts of the basin, driving significant variations in coastal upwelling and rainfall.

149. (B) Deepens significantly
During a strong El Niño event, the depth of the thermocline in the eastern equatorial Pacific deepens significantly. As the easterly trade winds weaken or reverse, warm water flows eastward, piling up along the South American coast. This thick layer of warm surface water pushes the thermocline downward, preventing cold, nutrient-rich deep water from reaching the photic zone.

150. (A) P-3, Q-4, R-1, S-2
The components of global ocean-atmosphere dynamics have distinct features: El Niño features warmer central Pacific temperatures, while La Niña is marked by stronger trade winds. The Southern Oscillation describes the atmospheric pressure seesaw, and the Indian Ocean Dipole's positive phase is associated with cooler waters in the eastern basin.

151. (D) Below-average rainfall and potential drought conditions
The impact of El Niño on Indian monsoon rainfall is generally associated with below-average precipitation and potential drought conditions. The warming of the equatorial Pacific alters global atmospheric circulation patterns, shifting the convection cells eastward and weakening the moist summer winds of the Southwest Monsoon,

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areas. These boundaries represent zones of convergence and upwelling where nutrient-rich waters stimulate phytoplankton blooms, drawing in grazing zooplankton and massive schools of planktivorous fish, which in turn attract larger pelagic predators.

173. (C) Optical ocean color sensor (e.g., OCM, MODIS)
The primary satellite sensors used to estimate ocean chlorophyll-a concentrations are optical ocean color sensors, such as MODIS or India's Ocean Colour Monitor. These sensors measure the intensity of green and blue light reflected from the sea surface, using specialized algorithms to calculate chlorophyll abundance based on the absorption properties of phytoplankton.

174. (C) Thermal infrared
Sea surface temperature is measured using the thermal infrared band of the electromagnetic spectrum. Satellites equipped with radiometers detect the thermal radiation naturally emitted by the top millimeter of the ocean surface, translating these radiative measurements into highly accurate temperature maps used to identify thermal fronts, currents, and eddies.

175. (A) Inability to penetrate dense cloud cover during the monsoon
A major limitation of using optical sensors for chlorophyll-a estimation is their inability to penetrate dense cloud cover, which is particularly problematic during the summer monsoon season. Because these sensors rely on visible light, thick clouds block their view of the sea surface, resulting in significant data gaps when fishing advisories are highly needed.

176. (D) Mesoscale ocean features like eddies and sea surface height anomalies
Altimetry data is used to augment Potential Fishing Zone forecasting by identifying mesoscale ocean features like eddies, currents, and sea surface height anomalies. By measuring precise distances between the satellite and the sea surface, altimeters map the topography of the ocean, helping scientists locate upwelling cyclonic eddies where fish aggregate.

177. (B) Upwelling of nutrient-rich water and higher productivity
A cyclonic ocean eddy in the Northern Hemisphere rotates counterclockwise, causing surface water to diverge and drawing cold, nutrient-rich water upward from the deep. This upwelling process delivers essential dissolved nutrients to the sunlit photic zone, fueling rapid phytoplankton growth and creating localized hotspots of high biological and fishery productivity.

178. (B) Reduced fuel and search time
The primary economic advantage of utilizing Potential Fishing Zone advisories for commercial fishermen is the significant reduction in fuel consumption and search time at sea. By directing fishing vessels straight to pre-identified productive fronts and eddies, these real-time advisories minimize random searching, lowering operational costs and increasing overall profitability.

179. (D) Sharp gradient between masses
On a sea surface temperature map, a thermal front appears as a sharp temperature gradient separating two distinct water masses. These thermal boundaries indicate active ocean currents, upwelling zones, or convergence areas where cold, nutrient-rich water meets warmer surface water, creating ideal conditions for plankton accumulation and pelagic fish schooling.

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180. (A) Small pelagic fish like sardines and mackerels
Small pelagic fish species like sardines, anchovies, and mackerels are the ideal targets for sea surface temperature and chlorophyll-based Potential Fishing Zone advisories. As primary consumers, these fish feed directly on plankton blooms concentrated along thermal fronts, aggregating in large, catchable schools that are easily located using satellite-derived ocean color data.

181. (A) Zone of thermal tolerance
The range of environmental temperatures within which a poikilothermic fish can survive indefinitely without suffering physiological failure is known as its zone of thermal tolerance. Within this range, the fish's metabolic and biochemical processes operate stably, whereas temperatures outside this zone trigger acute stress, cellular damage, and eventual mortality.

182. (B) Increased demand despite low solubility
An increase in water temperature elevates the metabolic rate and oxygen requirements of teleost fish, while simultaneously reducing the solubility and availability of dissolved oxygen in the water. This physiological mismatch forces

Kerala mudbanks during the monsoon. The calm waters and nutrient-rich conditions of the Chakara attract massive schools of these pelagic fish and benthic shrimp, allowing local fishers to safely launch small boats and secure abundant catches when offshore fishing is impossible.

163. (B) Subterranean discharge and rips
The formation of coastal mudbanks has been hypothesized to be influenced by subterranean freshwater discharge and rip currents. Under the hydrostatic pressure of heavy monsoon rains, underground aquifers discharge freshwater through the seabed, fluidizing the fine clay sediments and pushing them upward to form the suspended mud suspensions characteristic of Chakara.

164. (A) Safe landing sites during monsoon
The phenomenon of Chakara serves a critical socio-economic function by providing safe landing and launching sites for traditional fishers during the turbulent Southwest Monsoon. Because the mudbanks damp violent waves, fishers can operate their small crafts from these calm zones, securing livelihoods and food when the rest of the coast is inaccessible.

165. (B) Sediment release from agitation
The high nutrient content in mudbank waters is primarily due to nutrient release from the agitation and resuspension of benthic sediments. The strong wave action of the monsoon stirs up the fine-grained bottom mud, releasing trapped phosphates, nitrates, and organic matter into the water column, which fuels rapid biological productivity.

166. (C) The water within the mudbank exhibits high wave action and turbulence
The assertion that the water within a mudbank exhibits high wave action and turbulence is incorrect. In reality, the defining physical characteristic of a mudbank is its exceptionally calm and wave-damped surface, which is created by the viscous suspended mud absorbing nearly all wave energy, providing a quiet sanctuary along the coast.

167. (B) Salinity-driven deflocculation
The fine clay particles in a mudbank remain in suspension for extended periods due to salinity-driven deflocculation. The influx of freshwater from heavy monsoon rains lowers the salinity of the coastal waters, increasing the electrostatic repulsion between the clay particles, preventing them from clumping together and settling rapidly to the seafloor.

168. (B) Montmorillonite
The dominant clay mineral found in the fine sediments of the Kerala mudbanks is montmorillonite. This swelling clay possesses a highly active surface area and unique cohesive properties, allowing it to easily absorb water, form stable colloidal suspensions under low salinity, and effectively damp wave energy through its high viscosity.

169. (A) Sea Surface Temperature (SST) and Chlorophyll-a concentration
Potential Fishing Zones in India are forecast primarily by integrating satellite data on sea surface temperature and chlorophyll-a concentration. SST maps reveal thermal fronts and ocean currents, while chlorophyll-a measurements indicate phytoplankton abundance, allowing scientists to identify productive marine zones where pelagic fish are highly likely to aggregate.

170. (A) I, II, III, IV
The standardized workflow for generating Potential Fishing Zone advisories begins with satellite data acquisition of sea surface temperature and chlorophyll levels. This data is processed to extract oceanographic features like thermal fronts, which are integrated to generate precise maps, and finally disseminated to fishing communities via SMS, radio, and electronic display boards.

171. (A) Indian National Centre for Ocean Information Services (INCOIS)
The Indian National Centre for Ocean Information Services is the nodal government agency responsible for generating and disseminating Potential Fishing Zone advisories. Located in Hyderabad, this institute processes real-time satellite oceanographic data to create daily advisories, helping fishers optimize their operations and reduce search times across India's exclusive economic zone.

172. (D) They mark high productivity zones
Thermal fronts and chlorophyll gradients are excellent indicators for Potential Fishing Zones because they mark highly productive marine

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which reduces seasonal rainfall across the subcontinent.

152. (A) Oceanic Niño Index (ONI)
The Oceanic Niño Index is the primary ocean-atmosphere index used by scientists to monitor, classify, and forecast ENSO events. It measures three-month running averages of sea surface temperature anomalies in the east-central tropical Pacific, indicating whether the ocean is in an El Niño, La Niña, or neutral state.

153. (B) Warmer SSTs in the western Indian Ocean and cooler in the east
A positive Indian Ocean Dipole phase is characterized by warmer-than-average sea surface temperatures in the western Indian Ocean, near Africa, and cooler-than-average temperatures in the east, near Indonesia. This temperature gradient alters wind patterns, driving heavy rainfall in East Africa and drought conditions in Australia and parts of Southeast Asia.

154. (C) Starvation from anchoveta loss
The collapse of seabird populations off South America during an El Niño event is a direct result of starvation from the loss of anchoveta. When upwelling ceases and the anchoveta fishery collapses, seabirds lose their primary food source, causing widespread breeding failures, nest abandonment, and mass mortality among adult birds.

155. (B) Tropical fish and pelagic crabs
Tropical fish and pelagic red crabs are often monitored as biological indicator species to track the early stages of El Niño off the California coast. As warm water masses travel northward, these warm-water organisms migrate far outside their normal ranges, signaling shifts in ocean currents and thermal structures before physical sensors detect them.

156. (B) Changes in the ocean drive changes in the atmosphere, and vice versa
ENSO is a coupled ocean-atmosphere phenomenon because changes in ocean temperatures directly drive changes in atmospheric pressure and wind patterns, which in turn feed back to influence ocean currents and temperatures. This continuous, reciprocal interaction between the sea surface and the overlying air masses maintains and amplifies the climate oscillation.

157. (B) Chakara
The seasonal mudbanks that form along the southwest coast of India, particularly Kerala, are locally referred to as Chakara. These unique underwater formations create zones of calm water amid the turbulent monsoon seas, acting as temporary harbors that aggregate massive quantities of commercially valuable fish and shrimp resources.

158. (B) Southwest Monsoon
Chakara formations along the Kerala coast typically occur during the Southwest Monsoon, from June to August. The heavy rain, strong winds, and high wave action of the monsoon agitate the seabed, resuspending fine clay and silt particles that consolidate to form these transient, calm, and highly productive mudbanks.

159. (B) Calm waters with suspended mud
The physical state of a mudbank is characterized by calm, wave-damped waters containing highly suspended, fine-grained mud. Even when the surrounding open sea is battered by violent monsoon waves, the unique viscous properties of the fluid mud absorb and dissipate the incoming wave energy, creating a tranquil sanctuary along the shoreline.

160. (A) Calm water formation $\rightarrow$ Nutrient release from mud $\rightarrow$ Phytoplankton bloom $\rightarrow$ Fish aggregation
The high productivity of a Chakara system follows a specific sequence: first, wave energy is absorbed to form calm water; next, the agitated mud releases trapped nutrients into the water; this nutrient enrichment triggers a rapid phytoplankton bloom; and finally, massive schools of fish and prawns aggregate to feed in the calm area.

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161. (B) Energy loss in viscous fluid mud
The hydrodynamic mechanism responsible for the remarkable wave damping in a mudbank is energy loss within the viscous fluid mud. As ocean waves enter the shallow mudbank, their orbital motion interacts with the dense, semi-fluid suspension of fine clay particles, converting the wave's kinetic energy into heat through internal friction and viscosity.

162. (B) Prawns, sardines, and mackerels
Prawns, sardines, and mackerels are the dominant fishery resources harvested from the

the fish to expend more energy on ventilation to extract sufficient oxygen from an increasingly oxygen-depleted aquatic environment.

183. (B) Tolerate a wide range of salinities
Euryhaline fishes possess specialized osmoregulatory mechanisms that allow them to tolerate a wide range of environmental salinities. These adaptations enable them to transition smoothly between freshwater, estuarine, and marine environments by actively adjusting ion transport across their gills, drinking rates, and kidney function to maintain internal osmotic balance.

184. (B) Anadromous migration
The migration of fish from marine environments to freshwater rivers to spawn is termed anadromous migration. Species such as salmon and shad spend the majority of their adult lives feeding and growing in the open ocean before migrating upstream into freshwater systems, where their offspring hatch in highly oxygenated, predator-sparse headwaters.

185. (A) Gonad maturation and spawning
Gonad maturation and spawning in fish are directly regulated by seasonal changes in photoperiod and water temperature. These environmental cues trigger the endocrine system, stimulating the release of gonadotropin hormones that coordinate gamete development and initiate spawning behavior, ensuring that offspring hatch during periods of high food availability and favorable survival conditions.

186. (A) Excrete excess monovalent ions (e.g., Na^+, Cl^-)
During osmoregulation in a marine environment, teleost fish lose water and gain salts due to the hypertonic nature of seawater. To compensate, they drink seawater and utilize specialized chloride cells in their gills to actively excrete excess monovalent sodium and chloride ions against the concentration gradient, maintaining their internal osmotic homeostasis.

187. (B) Seek optimal temperature regimes for feeding and reproduction
Temperate fish species, such as winter flounder, undertake seasonal migrations primarily to seek optimal temperature regimes that support feeding, growth, and reproduction. By moving between shallow coastal bays in the spring and deeper offshore waters in the winter, they avoid lethal temperature extremes and maximize their metabolic and physiological performance.

188. (B) Fish lack ATP for basic metabolism
Hypoxia limits the spatial distribution of fish because it deprives their tissues of sufficient oxygen, preventing the aerobic generation of adenosine triphosphate needed for basic metabolism and active swimming. Without adequate ATP, fish suffer cellular damage, metabolic acidosis, and reduced physiological capacity, forcing them to avoid hypoxic zones entirely to survive.

189. (B) Oxygen supply capacity to tissues
The Oxygen- and Capacity-Limited Thermal Tolerance hypothesis proposes that a fish's thermal tolerance is restricted by its cardiovascular system's ability to supply sufficient oxygen to tissues at extreme temperatures. As temperature rises, metabolic oxygen demand exceeds the maximum rate of oxygen delivery, causing a decline in aerobic scope that limits survival.

190. (A) Both A and R are true and R is the correct explanation of A.
Freshwater teleosts live in a hypotonic environment relative to their body fluids, causing them to constantly gain water via osmosis across their permeable gill membranes. To prevent tissue swelling and maintain salt balance, they must excrete large volumes of highly dilute urine while actively absorbing essential salts back through their gills, making both statements true.

191. (A) Maximum growth and metabolic efficiency occur
The preferred temperature of a fish species typically aligns with the temperature range where its maximum growth rate, digestive capacity, and metabolic efficiency occur. Within this optimal thermal window, the fish maximizes its aerobic scope, allowing it to efficiently convert ingested food into somatic tissue and navigate its environment with minimal metabolic stress.

192. (B) Summer kill due to severe nocturnal oxygen depletion
Mass fish deaths in shallow, highly productive ponds during hot, cloudy summer days are due to summer kill caused by severe nocturnal oxygen depletion. High temperatures boost fish respiration rates while reducing oxygen

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solubility, and cloudy skies limit daytime photosynthesis, preventing oxygen replenishment while community respiration rapidly consumes all dissolved oxygen at night.

193. (D) Dinoflagellates
Harmful Algal Blooms, commonly known as red tides, are most frequently caused by the rapid proliferation of dinoflagellates. These single-celled, flagellated protists can form dense blooms under favorable nutrient and temperature conditions, discoloring the water and producing potent biotoxins that accumulate in the food web, causing severe marine mortality.

194. (D) Saxitoxin
Paralytic Shellfish Poisoning is a severe clinical syndrome caused by the ingestion of bivalve mollusks contaminated with saxitoxin, a potent neurotoxin produced by marine dinoflagellates. This toxin selectively blocks voltage-gated sodium channels in nerve and muscle tissues, preventing the transmission of action potentials and leading to rapid respiratory paralysis and death.

195. (B) Diatoms (e.g., Pseudo-nitzschia)
Amnesic Shellfish Poisoning is uniquely associated with domoic acid, a water-soluble amino acid produced primarily by marine diatoms of the genus Pseudo-nitzschia. During blooms, filter-feeding shellfish consume these diatoms and concentrate the toxin, which acts as a potent glutamate agonist that damages nerve cells in the mammalian hippocampus, causing memory loss and seizures.

196. (D) Inducing continuous nerve cell firing
Brevetoxins, which cause Neurotoxic Shellfish Poisoning, affect marine organisms and humans by binding to voltage-gated sodium channels in nerve fibers. This binding prevents the channels from closing, keeping them open at normal resting potentials and inducing continuous, uncontrolled nerve cell firing, which leads to neurological symptoms, cardiac disruption, and respiratory distress.

197. (B) Okadaic acid
Diarrhetic Shellfish Poisoning is a gastrointestinal illness caused by consuming bivalves that have accumulated okadaic acid, a lipophilic toxin produced by dinoflagellates. Okadaic acid inhibits key protein phosphatase enzymes in intestinal cells, disrupting cellular regulation and leading to hypersecretion of water, which causes severe diarrhea, nausea, and abdominal pain in humans.

198. (D) Gill clogging or oxygen depletion
Massive fish kills during non-toxic phytoplankton blooms are typically the result of physical gill clogging or severe dissolved oxygen depletion. The physical structure of dense algal cells can mechanically abrade and clog fish gills, causing asphyxiation, while the subsequent decomposition of the dying bloom by aerobic bacteria consumes all available oxygen in the water column.

199. (B) Microcystins
Cyanobacterial harmful algal blooms in freshwater systems frequently produce potent hepatotoxins known as microcystins. These cyclic peptide toxins are highly stable and resist boiling, selectively target liver cells in animals and humans, and inhibit protein phosphatases, leading to severe cellular damage, internal hemorrhaging, and potential liver failure upon ingestion.

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200. (A) P-3, Q-1, R-2, S-4
Different marine biotoxins are linked to specific poisoning syndromes: saxitoxin causes paralytic shellfish poisoning, whereas domoic acid leads to amnesic shellfish poisoning. Okadaic acid is the causative agent behind diarrhetic shellfish poisoning, and brevetoxin induces neurotoxic shellfish poisoning, representing highly distinct biochemical hazards in seafood consumption.

201. (B) Reef predators with bioaccumulated toxins
Ciguatera Fish Poisoning is contracted by consuming large, tropical reef predators that have bioaccumulated ciguatoxins. These toxins are originally produced by benthic dinoflagellates growing on coral reefs, which are consumed by herbivorous fish, metabolized into more toxic forms, and transferred up the food chain to concentrate in apex predators like barracudas and snappers.

202. (D) Karenia brevis
The causative organism for the Florida red tide is the dinoflagellate Karenia brevis. This marine species produces potent brevetoxins that can become aerosolized by wave action, causing respiratory distress in humans, while its high-density blooms lead to massive mortalities of

fish, sea turtles, manatees, and seabirds along affected coastal regions.

203. (D) Anthropogenic coastal eutrophication and global warming
Anthropogenic coastal eutrophication and global warming are major factors driving the increasing frequency and intensity of global harmful algal blooms. Nutrient enrichment from agricultural runoff provides excess fertilizers, while rising water temperatures create stable, stratified water columns that favor the rapid growth and dominance of toxic dinoflagellates and cyanobacteria.

204. (D) Blocking nerve impulse transmission
Saxitoxin exerts its lethal paralytic effect by blocking nerve impulse transmission along axonal membranes. By binding specifically to the outer pore of voltage-gated sodium channels, the toxin prevents sodium ions from entering nerve cells, halting the propagation of action potentials and causing rapid muscular paralysis that leads to respiratory failure.

205. (B) Treating the contamination at the site without removing the polluted material
In-situ bioremediation refers to the biological treatment of contaminated aquatic systems directly at the polluted site, without excavating or transporting the contaminated sediment or water. This approach utilizes microorganisms to degrade, transform, or neutralize pollutants in place, offering a cost-effective and minimally disruptive alternative to traditional engineering methods.

206. (B) The addition of specifically cultured, specialized microbial strains to degrade a target pollutant
Bioaugmentation is an aquatic bioremediation technique that involves adding specifically cultured, specialized microbial strains to a polluted water body to accelerate the degradation of a target contaminant. This method is used when indigenous microbial communities lack the metabolic pathways required to break down complex, persistent synthetic organic pollutants.

207. (D) Modifying conditions for native microbes
Biostimulation differs from bioaugmentation because it focuses on modifying environmental conditions to stimulate the growth and metabolic activity of indigenous microorganisms. Instead of adding foreign bacterial strains, biostimulation involves injecting limiting nutrients, oxygen, or electron acceptors into the polluted aquatic system to accelerate the natural biodegradation processes.

208. (A) Aquatic plants and macroalgae
Phytoremediation is a clean-up technology that utilizes aquatic plants and macroalgae to extract, accumulate, neutralize, or stabilize hazardous pollutants from contaminated water and sediments. These plants absorb toxic heavy metals, excess agricultural nutrients, and organic chemicals through their roots, concentrating them in their tissues for safe harvesting and disposal.

209. (B) Mimic natural wastewater treatment
Constructed wetlands are engineered systems designed to mimic the physical, chemical, and biological treatment processes of natural wetlands to treat wastewater. They utilize aquatic vegetation, gravel beds, and diverse microbial communities to filter suspended solids, absorb excess nutrients, and degrade organic pollutants in aquaculture and municipal effluents.

210. (B) I and III
Ex-situ bioremediation provides greater control over environmental parameters in a controlled facility, whereas in-situ techniques are actually less disruptive to ecosystems because they avoid sediment dredging. Furthermore, bioaugmentation can fail if introduced microbes cannot compete with native flora, making the first and third statements correct and accurate.

211. (A) Mycoremediation
The application of fungi, specifically white-rot species, to degrade complex and persistent organic pollutants in contaminated aquatic environments is termed mycoremediation. Fungi secrete powerful extracellular lignin-modifying enzymes, such as laccases and peroxidases, which non-specifically break down stable chemical structures like PCBs, petroleum hydrocarbons, and synthetic dyes.

212. (D) Halophilic microbial bioreactors
Halophilic microbial bioreactors are specifically engineered bioprocess systems used to treat hypersaline aquaculture and industrial effluents. Traditional freshwater wastewater microbes cannot survive in high-salinity conditions,

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of both the Moon and the Sun, making the claims about equatorial Coriolis strength and solar-only tidal forces completely incorrect and scientifically inaccurate.

131. (B) Fetch
Wind-generated wave height is determined by three key factors: wind speed, wind duration, and fetch. Fetch refers to the uninterrupted distance of open water over which the wind blows in a constant direction, allowing kinetic energy to transfer continuously from the atmosphere to the sea surface, generating much larger waves.

132. (C) Two equal high and low tides
A semi-diurnal tidal pattern is characterized by two high tides and two low tides of approximately equal height occurring during each lunar day. This cycle, common along the Atlantic coasts of North America and Europe, repeats every twelve hours and twenty-five minutes, driven by the gravitational forces of the Moon and Sun.

133. (B) Away from the coastline
Coastal upwelling occurs when wind-driven Ekman transport moves warm, surface water away from the coastline. To replace this displaced water mass, cold, dense, and nutrient-rich water is drawn upward from the deeper ocean layers, fueling intense primary productivity and supporting highly productive pelagic fisheries in the photic zone.

134. (D) Fuel photic zone primary production
Upwelling regions are biologically significant because they bring deep, cold, and nutrient-rich waters to the sunlit surface photic zone. This influx of essential dissolved nutrients, such as nitrates and phosphates, fuels rapid phytoplankton growth, creating highly productive marine food webs that support some of the largest fisheries in the world.

135. (C) Winds moving surface water towards the coast, pushing it downward
Coastal downwelling is typically associated with winds that drive Ekman transport toward the shoreline, piling up surface water and pushing it downward. This downward movement transports warm, oxygen-rich surface waters to deeper layers but limits the supply of deep-water nutrients to the photic zone, generally resulting in lower primary and fishery productivity.

136. (C) Peruvian Anchoveta
The Peruvian Anchoveta fishery is highly dependent on the Humboldt Current upwelling system off the west coast of South America. This intense, wind-driven upwelling delivers massive quantities of nutrients to the photic zone, supporting immense diatom blooms that feed the vast schools of anchoveta, making it one of the most productive monospecific fisheries globally.

137. (D) Trade winds and Coriolis reversal
Equatorial upwelling is driven by the divergence of surface ocean currents along the equator. This divergence occurs because the trade winds blow westward, while the Coriolis effect deflects water northward in the Northern Hemisphere and southward in the Southern Hemisphere, forcing cold, nutrient-rich deep water to rise to the surface.

138. (B) Collapse of planktivorous populations
The close correlation between upwelling and pelagic fishery production means that a sudden cessation of upwelling will cause a rapid collapse of planktivorous populations. Without the constant supply of deep nutrients, phytoplankton blooms disappear, starving the herbivorous zooplankton and the massive schools of small pelagic fish that rely on them for survival.

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139. (B) South
In the Northern Hemisphere, upwelling along a western coast is induced by winds blowing towards the south. Due to the Coriolis effect, these northerly winds drive surface water ninety degrees to the right, which is offshore, forcing cold, nutrient-rich subsurface water to rise along the coast to replace the displaced surface water.

140. (A) Both A and R are true and R is the correct explanation of A.
Upwelling zones support highly productive pelagic fisheries because they supply massive amounts of dissolved nutrients to the photic zone. This nutrient influx fuels short, highly efficient food chains dominated by large diatoms and planktivorous fish, minimizing energy loss across trophic levels and explaining why these small ocean regions yield immense fish biomass.

141. (B) Low production and matter buildup
Downwelling zones are ecologically characterized by low primary production and a buildup of downwelling surface organic matter. Because

colonies or filaments that mechanically clog the feeding appendages of grazers like Daphnia, causing zooplankton to avoid them and allowing cyanobacteria to dominate the water.

223. (B) Refuge for grazers and stabilization
Submerged aquatic macrophytes play a vital role in successful lake biomanipulation by providing critical refuge for large grazing zooplankton to hide from planktivorous fish. Additionally, these plants stabilize benthic sediments to prevent nutrient resuspension, compete with phytoplankton for dissolved nutrients, and release allelopathic chemicals that inhibit algal growth.

224. (B) Directly enhance the survival and size of herbivorous zooplankton
Planktivore removal, such as netting out abundant planktivorous roach and bream, is a direct biomanipulation technique used to enhance the survival and average size of herbivorous zooplankton. By reducing fish predation pressure, large-bodied grazers like Daphnia can establish dense populations, exerting intense grazing pressure on phytoplankton and restoring water clarity.

225. (B) Rebound of planktivore populations or compensation by inedible algae
Biomanipulation interventions often face long-term instability due to the rapid rebound of planktivorous fish populations or ecological compensation by inedible algae. If external nutrient inputs remain high, fast-growing fish can quickly overpopulate the system, or the phytoplankton community may shift to toxic, colony-forming cyanobacteria that zooplankton cannot physically consume.

226. (B) Turbid phytoplankton state to a clear-water macrophyte state
In the context of alternative stable states, biomanipulation aims to shift a shallow, eutrophic lake from a turbid phytoplankton-dominated state to a clear-water state dominated by submerged macrophytes. This transition is achieved by altering the food web to enhance zooplankton grazing, lowering turbidity, and allowing light to reach the lake bed.

227. (D) Adding alum to precipitate phosphorus
To reduce internal phosphorus loading in eutrophic lakes, managers often use chemical techniques like adding alum (aluminum sulfate) to the water. Alum binds with dissolved inorganic phosphorus to form an insoluble aluminum phosphate floc, which precipitates out of the water column and seals the lake sediments, preventing nutrient release.

228. (D) Resuspending mud and releasing nutrients
Benthivorous fish, such as common carp, negatively impact lake restoration efforts by foraging in bottom sediments. This feeding behavior physically uproots submerged aquatic macrophytes, resuspends fine mud, and releases trapped nutrients back into the water column, increasing turbidity and fueling phytoplankton blooms that counter the goals of biomanipulation.

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229. (B) Conditioning film of adsorbed organic molecules
Marine biofouling begins immediately upon submergence of any solid surface with the formation of a biochemical conditioning film. This initial process occurs within minutes as dissolved organic molecules, such as glycoproteins and humic substances, adsorb onto the substrate, altering its surface charge and properties to facilitate subsequent microbial attachment.

230. (A) II, III, IV, I, V
Marine biofouling progresses through a predictable sequence of stages, starting with the adsorption of a chemical conditioning film, followed by primary bacterial attachment to form a biofilm. Next, secondary microfoulers like diatoms settle on the surface, paving the way for macrofoulers like barnacles, which eventually mature into a complex climax community.

231. (C) Biofilms containing bacteria, diatoms, and protozoa
The term microfouling refers specifically to the early, microscopic stages of biofouling characterized by the accumulation of a complex biofilm. This layer is composed of bacteria, unicellular diatoms, and protozoans embedded in a self-produced matrix of extracellular polymeric substances, which conditions the surface for larger macrofouling organisms.

232. (D) Increased drag and fuel consumption
A major economic impact of marine biofouling on the shipping industry is increased hydrodynamic drag on ship hulls. The attachment of barnacles, algae, and tubeworms increases surface

roughness, which disrupts water flow and requires vessels to burn significantly more fuel to maintain speed, rising operating costs and greenhouse gas emissions.

233. (A) Caused severe endocrine disruption
Tributyltin was globally banned because it caused severe endocrine disruption and toxicity in non-target marine organisms. This highly effective biocide leached from ship paints into water, inducing imposex—the development of male characteristics in female sea snails—and bioaccumulating in marine food webs, posing significant risks to coastal ecosystems.

234. (D) Reduces water flow and oxygen exchange
In aquaculture, biofouling on net cages is highly detrimental because it physically blocks the mesh openings, reducing water flow and dissolved oxygen exchange. This restriction of fresh water causes waste metabolites to accumulate and oxygen levels to drop, stressing the cultured fish, lowering growth rates, and increasing susceptibility to diseases.

235. (B) Barnacles and tube worms
Hard macrofoulers are sessile marine organisms that construct rigid, calcareous protective structures on submerged surfaces. This group is represented by barnacles, tube worms, and bivalves, whose mineralized shells adhere tightly to substrates, causing significant physical damage, surface corrosion, and hydrodynamic drag on marine vessels and coastal infrastructure.

236. (D) Low-energy hydrophobic polymers
Modern, environmentally friendly anti-fouling coatings often rely on low-energy hydrophobic polymers, such as silicone or fluoropolymer-based foul-release coatings. These materials create an extremely smooth, slippery surface with low surface energy, which prevents biofouling organisms from establishing strong adhesive bonds, allowing them to be washed off easily by water currents.

237. (B) Structures attract species to sub-optimal zones
The ecological trap hypothesis suggests that artificial marine structures and biofouling can attract organisms to sub-optimal zones where survival or reproductive success is low. Although these structures offer abundant physical settlement space, they may expose resident species to high concentrations of toxins, heavy shipping traffic, or intense localized predation.

238. (B) Hull fouling on international commercial vessels and recreational boats
Biofouling facilitates the spread of invasive species primarily through hull fouling on international commercial ships and recreational boats. Organisms attached to vessel hulls are transported across global oceanic boundaries, allowing non-indigenous species to quickly colonize new marine environments, disrupt native food webs, and outcompete local species.

239. (A) Exudation of secondary metabolites
Many marine organisms, including corals, sponges, and seaweeds, naturally prevent biofouling on their surfaces by exuding chemical secondary metabolites. These natural biocides inhibit bacterial attachment, prevent diatom colonization, and deter larval settlement of macrofoulers, serving as a biological defense mechanism that inspires the design of non-toxic anti-fouling coatings.

240. (D) A is false but R is true.
The claim that copper-based paints are sustainable and pose zero ecological risk is false, as copper leaches into the water and can reach toxic concentrations that harm non-target organisms in estuaries. However, copper is indeed an essential micronutrient for biological life in trace amounts, making the assertion false and the reason true.

241. (C) Existence value and bequest value
Non-use values of aquatic ecosystems represent the economic value derived from a resource without physically interacting with it. This includes existence value, which is the value of knowing an ecosystem exists in a healthy state, and bequest value, which represents the value placed on preserving the resource intact for future generations.

242. (A) Surveying willingness to pay (WTP)
The Contingent Valuation Method is a survey-based economic technique used to estimate the value of non-market ecosystem services by directly asking individuals about their willingness to pay for environmental preservation. This method creates a hypothetical market, allowing researchers to quantify non-use values like the existence of endangered species.

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243. (D) Travel cost method
To estimate the recreational value of a coastal marine park, the travel cost method is the most appropriate non-market valuation technique. This approach uses the time and financial expenses that visitors incur to travel to the site as a proxy for its recreational value, helping to model consumer demand.

244. (B) Differences in real estate pricing
The Hedonic Pricing Method is used to estimate the economic value of environmental amenities by analyzing differences in local real estate pricing. This method assumes that the price of a property is influenced by its environmental attributes, such as proximity to clean beaches or scenic ocean views, allowing researchers to isolate the amenity's value.

245. (D) Construction costs of infrastructure
The Replacement Cost Method estimates the economic value of an ecosystem service based on the cost of constructing artificial infrastructure to replace it. For example, the value of a mangrove forest's wave-damping and storm protection service is calculated as the cost of building concrete seawalls to provide equivalent coastal protection.

246. (B) The value placed on conserving a resource for potential future direct or indirect use
In environmental economics, option value is the willingness of individuals to pay to conserve a natural resource today to preserve the option of using it in the future. This value reflects uncertainty about future preferences or resource availability, ensuring that biodiversity and habitats remain intact for potential future discoveries or recreational opportunities.

247. (B) It is susceptible to hypothetical bias, where respondents overstate or understate their true willingness to pay
A major limitation of the Contingent Valuation Method is its susceptibility to hypothetical bias, where survey respondents overstate or understate their true willingness to pay because no actual financial transactions occur. This discrepancy between stated intentions and real behavior can lead to inaccurate valuations of aquatic ecosystem services and resources.

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248. (B) Indirect use value
The economic value derived from the regulatory and supporting functions of aquatic ecosystems, such as wetland water purification, coastal storm defense, and marine carbon sequestration, is classified as indirect use value. These services support human well-being and economic activities indirectly, without requiring the physical extraction or harvesting of the resource.

249. (B) An assigned monetary value to an unpriced environmental asset or service based on its true opportunity cost
Shadow pricing is an economic method used to assign a monetary value to unpriced environmental assets, services, or social benefits that lack a formal market price. By estimating the true opportunity cost of conserving or losing these resources, shadow prices help policymakers integrate ecosystem values into cost-benefit analyses for coastal development projects.

250. (A) P-3, Q-1, R-2, S-4
Environmental valuation methods are matched to specific contexts: the travel cost method is used for recreational fishing sites, while hedonic pricing assesses coastal real estate values. Contingent valuation estimates the existence value of endangered species, and the replacement cost method quantifies the value of natural coastal flood defenses in place.

251. (A) Commercial harvesting of reef fish and lobsters
Direct use value represents the benefits derived from the physical extraction or non-extractive utilization of an ecosystem's resources. The commercial harvesting of reef fish, crabs, and lobsters represents a classic extractive direct use value of a coral reef, generating immediate market revenue and supporting local coastal livelihoods.

252. (A) Use values and non-use values
The Total Economic Value framework is the mathematical sum of all use values and non-use values associated with an ecosystem. Use values encompass direct, indirect, and option values, while non-use values include existence and bequest values, providing a comprehensive economic framework to evaluate the total worth of natural systems.

reduction plans. Because coastal residents understand local hazards, geography, and social dynamics, their active involvement creates highly relevant evacuation routes, highly realistic shelter plans, and effective communication channels, greatly enhancing overall resilience.

273. (B) Sendai Framework for Disaster Risk Reduction
The primary international framework guiding global disaster risk reduction is the Sendai Framework for Disaster Risk Reduction. Signed by member states, this fifteen-year voluntary agreement outlines key priorities to reduce disaster risk, strengthen governance, invest in resilience, and enhance preparedness to "build back better" following hazard events.

274. (B) Multi-channel alerts in local languages
For coastal fishers, a reliable indicator of a highly functional early warning system is the dissemination of multi-channel alerts in local languages. Utilizing radio, mobile SMS, sirens, and community leaders ensures that warnings reach isolated fishing families quickly, allowing them to secure their boats and evacuate to safety before conditions degrade.

275. (A) Global sea-level rise
Coastal vulnerability to storm surges is critically exacerbated by the long-term anthropogenic factor of global sea-level rise. Rising ocean levels elevate the baseline water height, allowing storm surges driven by tropical cyclones to travel further inland, causing deeper flooding, faster coastal erosion, and greater damage to low-lying fishing villages.

276. (B) A community recovering rapidly and "building back better" after a hazard event
Resilience in coastal community disaster risk reduction is best demonstrated by a community's capacity to recover rapidly and "build back better" following a hazard event. This involves restoring livelihoods, improving early warning systems, and rebuilding coastal defenses to be stronger, reducing future vulnerability to extreme environmental events.

277. (B) Providing substrate for fish biomass
Artificial Reefs enhance coastal habitats primarily by providing durable physical substrates for benthic organisms and fish biomass to colonize. Deployed on barren seafloors, these structures offer crucial shelter, feeding grounds, and spawning sites, directly stimulating biological colonization and attracting diverse marine species to enhance localized fishery resources.

278. (B) Formation of a bacterial and diatom biofilm
Ecological succession on a newly deployed artificial reef begins with the rapid formation of a biochemical conditioning film and a bacterial and diatom biofilm. This microscopic layer alters the surface chemistry of the concrete or steel, attracting secondary sessile invertebrates like hydrozoans and bryozoans that pave the way for complex macrofoulers.

279. (C) Scrap tires with nylon ropes
Scrap tires bound with nylon ropes are highly discouraged for constructing artificial reefs due to environmental toxicity and structural instability. Over time, physical wave action breaks down the binding ropes, dispersing tires across the seafloor, while the rubber leaches toxic chemicals that harm developing marine organisms, causing ecological damage.

280. (B) Increase biomass or aggregate fish
The attraction versus production debate regarding artificial reefs questions whether these structures actually increase total fish biomass and production or simply aggregate existing fish from nearby areas. While aggregation makes harvesting easier, it risks overfishing if the reef does not actively enhance larval survival and net biological growth.

281. (A) Increase habitat and niche availability
The deployment of complex, multi-level concrete artificial reef modules primarily aims to increase habitat complexity and niche availability. By featuring diverse hole sizes, internal tunnels, and vertical structures, these modules provide optimal shelter for various species and size classes, reducing predation pressure on juveniles and maximizing local biodiversity.

282. (B) Interstitial space (crevices and holes)
To mimic the complexity of natural coral reefs, artificial structures are engineered to feature high interstitial space, including numerous crevices and holes. This physical design provides critical shelter for juvenile fishes, crabs, and lobsters to escape larger predators, while creating diverse microhabitats that support complex, multi-trophic marine communities.

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aquifers from saltwater intrusion, making their physical preservation vital for coastal resilience.

263. (D) Environmental Impact Assessment (EIA)
An Environmental Impact Assessment is a fundamental planning tool used in ICZM to evaluate the potential environmental, social, and economic consequences of a proposed large-scale coastal project. Conducting an EIA helps developers and regulators identify potential negative impacts early, allowing them to design mitigation strategies to prevent coastal habitat degradation.

264. (A) Tides, waves, sea-level rise, and shoreline changes
The hazard line mapped along the Indian coast for disaster management takes into account tides, wave climate, sea-level rise, and long-term shoreline changes. This line identifies areas highly vulnerable to coastal flooding, erosion, and storm surges, helping authorities plan setback zones and construct defensive infrastructure to protect coastal communities.

265. (A) Exposure, sensitivity, and adaptive capacity
Vulnerability assessments for coastal fishing communities evaluate three key components: exposure, sensitivity, and adaptive capacity. Exposure measures the physical impact of environmental hazards, sensitivity assesses the community's dependence on vulnerable resources, and adaptive capacity determines their ability to cope, recover, and adjust to these disturbances over time.

266. (C) Ability to cope and adjust
In the context of disaster risk reduction, adaptive capacity refers to the ability of a system or community to cope with, recover from, and adjust to hazards. This includes access to financial resources, diversified livelihoods, social networks, and educational tools that enable coastal fishers to absorb shocks and rebuild effectively.

267. (D) End-to-end community communication
Early warning systems for coastal hazards are most effective when they feature robust end-to-end community communication. This ensures that accurate, timely alerts are not only generated by advanced scientific instruments but are also successfully transmitted and understood by local fishing families, triggering immediate, highly coordinated safety actions.

268. (D) High dependence on a single livelihood, such as near-shore fishing
A community's sensitivity to coastal hazards is heavily increased by high dependence on a single, highly vulnerable livelihood, such as near-shore fishing. When a storm destroys boats, gear, and coastal habitats, families with no alternative income sources suffer complete economic collapse, prolonging recovery times compared to households with diversified income.

269. (B) Mangrove afforestation and dune restoration
Soft engineering solutions for coastal disaster risk reduction involve working with natural processes, such as mangrove afforestation and sand dune restoration. These biological approaches dissipate wave energy, stabilize shoreline sediments, and reduce flooding risk naturally, providing vital habitats for fisheries while avoiding the ecological damage associated with concrete seawalls.

270. (B) Preparedness, mitigation, and early warning
Disaster Risk Reduction emphasizes transitioning from a reactive post-disaster response to a proactive approach focusing heavily on preparedness, hazard mitigation, and early warning systems. This strategy aims to reduce vulnerability, strengthen coastal defense infrastructure, and fully prepare communities before a hazard strikes, minimizing the loss of life and economic assets.

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271. (B) Government-implemented fishing bans matched with livelihood compensation schemes
An institutional coping mechanism during the cyclone season is the implementation of seasonal fishing bans matched with financial livelihood compensation schemes. This government intervention keeps fishers off dangerous waters while providing essential economic support to help families purchase food and maintain household security when fishing is legally prohibited.

272. (D) Local knowledge and community participation are central to formulating DRR plans
Community-based Disaster Risk Management ensures that local knowledge and community participation are central to formulating risk

253. (B) Balance economic and social sustainability
The primary objective of Integrated Coastal Zone Management is to balance environmental protection with economic and social sustainability across the coastal zone. By coordinating the activities of multiple sectors and stakeholders, ICZM aims to optimize coastal resource use, reduce user conflicts, and preserve vital habitats while supporting sustainable development.

254. (A) CRZ-I
Under India's Coastal Regulation Zone notification, ecologically sensitive areas like mangroves, coral reefs, sand dunes, and national parks are classified under CRZ-I. This zone receives the highest level of regulatory protection, strictly prohibiting new industrial activities, commercial construction, and waste disposal to fully preserve these highly vulnerable coastal ecosystems.

255. (C) The water area from the Low Tide Line to 12 nautical miles seaward
CRZ-IV under the Indian regulatory framework encompasses the marine water area extending from the Low Tide Line to twelve nautical miles seaward, representing the territorial sea boundary. This zone also includes tidal water bodies like estuaries and creeks, regulating discharges and activities that could impact coastal water quality and fisheries.

256. (D) Coastal areas that have been substantially built up or are located within municipal limits
CRZ-II is the regulatory classification assigned to coastal areas that have already been substantially built up or are located within defined municipal limits. Development in this zone is allowed but regulated, permitting the construction of buildings on the landward side of existing authorized roads or structures to manage urban coastal growth.

257. (B) 12 nautical miles
The seaward boundary for coastal regulation under India's CRZ notification is measured up to the territorial water limit of twelve nautical miles. This marine zone, managed under CRZ-IV, regulates activities like waste discharge, dredging, and underwater pipelines to prevent pollution and protect the health of near-shore marine habitats and fisheries resources.

258. (B) Integrating policies and management practices across all economic sectors operating in the coastal zone
A core principle of ICZM is a multi-sectoral approach, which involves integrating policies and management practices across all economic sectors operating in the coastal zone. By coordinating fisheries, tourism, industrial development, and nature conservation collectively, this approach prevents fragmented decision-making and minimizes resource conflicts while promoting sustainable development.

259. (A) 50 meters or 200 meters, depending on the population density
The No Development Zone in rural coastal areas under CRZ-III extends up to fifty or two hundred meters from the High Tide Line, depending on local population density. This buffer zone is designed to protect vulnerable coastal communities from erosion and storm surges while minimizing human-induced habitat degradation along the shoreline.

260. (A) High Tide Line (HTL)
The baseline from which Coastal Regulation Zone boundaries are primarily delineated is the High Tide Line. The HTL represents the line on the shore up to which the highest high tide reaches during spring tides, serving as the standardized reference boundary for mapping setbacks and regulating development landward.

261. (B) Engaging local communities, industries, and governments collaboratively in the planning process
Stakeholder participation in ICZM involves actively engaging local communities, fishers, private industries, and government bodies collaboratively in the planning and decision-making process. This inclusive approach ensures that local socio-economic needs and traditional knowledge are integrated with scientific data, increasing compliance, reducing conflicts, and promoting sustainable coastal resource management.

262. (B) Sand dunes
Sand dunes are explicitly protected from any development or construction under the CRZ-I classification due to their geomorphological importance. These natural dunes act as crucial barriers against storm surges, high waves, and coastal erosion, while protecting freshwater

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283. (C) Presence of long-lived macro-benthos
A major biological indicator of a mature and stable artificial reef community is the presence of slow-growing, long-lived macro-benthos, such as hard corals and sponges. While mobile fish colonize the structure quickly, the establishment of mature benthic invertebrates indicates a stable physical environment that has undergone extensive ecological succession.

284. (A) Depth, light penetration, current speed, and substrate orientation
Benthic succession on an artificial reef is heavily influenced by environmental factors such as depth, light penetration, current speed, and substrate orientation. These physical variables determine which pioneering larvae can settle, survive, and grow, shaping the community structure of encrusting algae, corals, and sessile invertebrates over time.

285. (B) Trawling ground conflict and snagging
A major risk of deploying artificial reefs without proper geographic planning is the creation of conflicts with commercial trawlers due to gear snagging. Unmapped structures can shred expensive bottom-trawling nets, while some reefs are intentionally deployed to act as anti-trawling barriers, requiring careful spatial planning to balance different coastal fisheries.

286. (B) High density of small complex refugia
The feature of an artificial reef design that best facilitates the survival of juvenile fishes is a high density of small, complex refugia. Tiny crevices and narrow openings allow small fish to hide safely from larger piscivores, which are physically blocked from entering, significantly increasing recruitment success and biomass.

287. (B) Rigs-to-Reefs
Decommissioned offshore oil rigs left in the ocean to serve as marine habitats is an application of the rigs-to-reefs concept. Instead of fully removing these massive steel platforms, their underwater structures are left in place to continue supporting productive ecosystems of invertebrates and fish, saving decommissioning costs while enhancing fisheries.

288. (B) Climate-dependent climax communities
Compared to natural reefs, artificial reefs generally exhibit climate-dependent climax communities that vary based on local oceanographic conditions. Although their physical materials differ from natural rocks, long-term ecological succession eventually establishes biological assemblages of algae, invertebrates, and fishes that closely resemble nearby natural habitats under similar climate regimes.

289. (B) Associate with floating objects in the open ocean for shelter, feeding, or spatial reference
Fish Aggregating Devices are utilized based on the natural behavioral tendency of pelagic fish to associate with floating objects in the open ocean. This behavioral response provides fish with potential shelter from predators, opportunities for feeding, or a spatial reference point to facilitate schooling in featureless marine environments.

290. (C) Tropical tunas (e.g., Skipjack, Yellowfin)
Drifting FADs are extensively utilized by commercial purse seine fleets primarily to target tropical tunas, such as skipjack and yellowfin. These fast-swimming pelagic species aggregate in massive numbers beneath drifting logs or engineered rafts, allowing fishing vessels to easily locate and capture entire schools with high efficiency.

291. (A) Lure tunas into nutrient-poor waters
The ecological trap hypothesis suggests that drifting FADs lure migrating tunas away from their natural routes into nutrient-poor ocean waters. Because the fish follow the drifting structures rather than natural temperature and food gradients, they may experience reduced growth rates, poor physiological health, and increased mortality in unproductive zones.

NODIA

292. (B) Are anchored for localized fishing
Moored FADs differ from drifting FADs because they are securely anchored to the seafloor to support localized fishing. These stationary structures, often deployed near coastal communities, aggregate pelagic fish in a predictable location, allowing small-scale, artisanal fishers to secure stable catches while reducing fuel expenditures and travel distances.

293. (B) Anchor and mooring line integrity
The primary hydrodynamic consideration when designing a moored FAD is to ensure the integrity of the anchor and mooring line. These structures must withstand intense ocean currents, high winds, and strong waves, requiring

(B) Global Biodiversity Hotspots concept - Norman Myers
(C) IUCN Red List establishment - United Nations Environment Programme
(D) World Conservation Strategy - World Bank

2010

10. Consider the following statements regarding biodiversity levels:
I. Genetic diversity prevents inbreeding depression.
II. Species diversity is measured only by species richness.
III. Ecosystem diversity encompasses interactions between biotic and abiotic components.
Which of the above statement(s) is/are CORRECT?
(A) I and II
(B) II and III
(C) I and III
(D) I only

2010

11. Which metric is most indicative of low genetic diversity in a cultured fish population?
(A) High fixation index ($F_{\{ST\}}$)
(B) High polymorphism
(C) Increased heterozygosity
(D) Low inbreeding coefficient

2014

12. The presence of numerous distinct color morphs in Poecilia reticulata (guppy) populations best illustrates which biodiversity concept?
(A) Gamma diversity
(B) Beta diversity
(C) Genetic diversity
(D) Ecosystem diversity

2012

13. Which spatial scale of diversity measures the species turnover between two distinct aquatic habitats, such as a lake and its adjacent wetland?
(A) Alpha diversity
(B) Gamma diversity
(C) Delta diversity
(D) Beta diversity

2012

14. In aquatic ecosystems, alpha diversity is most accurately defined as the:
(A) Total species richness across a large regional landscape
(B) Rate of change in species composition along an environmental gradient
(C) Diversity of species within a single localized habitat or community
(D) Genetic variability within a single keystone species

2009

15. If three separate ponds have identical species richness but completely different species compositions, their combined regional profile will exhibit:
(A) Low alpha and low beta diversity
(B) Moderate alpha and high beta diversity
(C) High alpha and low gamma diversity
(D) Low alpha and high genetic diversity

2017

16. Which formula conceptually represents gamma diversity based on Whittaker's multiplicative model?
(A) Gamma = Alpha + Beta
(B) Gamma = $\frac{\text{Alpha}}{\text{Beta}}$
(C) Gamma = Beta − Alpha
(D) Gamma = Alpha × Beta

2006

17. When comparing the benthic macroinvertebrate communities of an upstream riffle and a downstream pool, a high beta diversity value indicates:
(A) The habitats possess distinct and unique species assemblages
(B) Both habitats share the majority of species
(C) The total number of species in the river basin is low
(D) There is intense genetic introgression between the populations

2004

18. Gamma diversity in marine spatial planning is most relevant when assessing:
(A) The diversity of coral species on a single reef patch
(B) The difference in fish species between a mangrove and a seagrass bed
(C) The total biodiversity of an entire coastal eco-region
(D) The allelic frequency of a single pelagic fish stock

2010

19. A researcher calculating the Jaccard index between two estuaries is primarily investigating:
(A) Beta diversity
(B) Alpha diversity
(C) Gamma diversity
(D) Intraspecific genetic diversity

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CHAPTER 07
Aquatic Biodiversity and Conservation

2011

1. Who among the following is widely credited with introducing the term "biological diversity" to the scientific community before it was contracted to "biodiversity"?
(A) Raymond F. Dasmann
(B) E. O. Wilson
(C) Thomas Lovejoy
(D) Walter G. Rosen

2025

2. Which fundamental level of biodiversity serves as the primary basis for speciation and evolutionary adaptation to changing environments?
(A) Species diversity
(B) Ecosystem diversity
(C) Genetic diversity
(D) Functional diversity

2003

3. In historical contexts, the formal contraction of "biological diversity" to "biodiversity" was first utilized during the planning of the National Forum on BioDiversity in 1986 by which scientist?
(A) Walter G. Rosen
(B) Norman Myers
(C) Paul Ehrlich
(D) Arthur Tansley

2011

4. Which concept best defines ecosystem diversity within an aquatic context?
(A) The variety of alleles present in a specific fish population
(B) The relative abundance of fish species in a singular lake
(C) The variation of phenotypes across a species' geographical range
(D) The variation in habitats, biotic communities, and ecological processes

2011

5. How does genetic drift primarily affect the genetic diversity of small, isolated aquatic populations?
(A) It significantly increases genetic diversity through rapid and beneficial mutations
(B) It causes random fluctuations in allele frequencies, reducing diversity
(C) It consistently enhances heterozygosity across all available genetic loci
(D) It stabilizes and balances allele frequencies through strong selective pressures

2007

6. Which statement INCORRECTLY describes the relationship between species richness and ecosystem stability according to the diversity-stability hypothesis?
(A) Higher species richness generally leads to greater community resilience
(B) Redundant species provide ecological insurance against perturbations
(C) Lower species diversity accelerates recovery from severe environmental stress
(D) Complex food webs derived from high species diversity buffer against invasive species

2015

7. The structural complexity of a coral reef primarily exemplifies which level of biodiversity?
(A) Genetic diversity
(B) Alpha diversity
(C) Intraspecific diversity
(D) Ecosystem diversity

2025

8. In assessing biodiversity, how is "functional diversity" typically differentiated from "species diversity"?
(A) It categorizes species based on their ecological roles and traits
(B) It measures the evolutionary age of species present
(C) It counts the absolute number of distinct taxa in a defined area
(D) It evaluates the geographical distribution of genetic mutations

2008

9. Identify the correct pair regarding the historical development of biodiversity conservation frameworks.
(A) Convention on Biological Diversity - 1972 Stockholm Conference

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durable materials and heavy anchors to prevent the FAD from breaking loose and drifting into deep waters.

294. (B) Co-associated juveniles and sharks
A major ecological concern with FAD-based purse seine fisheries is the high rate of bycatch, particularly of co-associated juvenile tunas and pelagic sharks. Because FADs aggregate a diverse array of marine life, surrounding the entire structure with a large net captures non-target species that feed or seek shelter alongside the target tuna.

295. (B) Non-entangling biodegradable designs
To mitigate bycatch and marine pollution, modern FAD designs emphasize the use of non-entangling, biodegradable materials. These eco-friendly structures use natural ropes and canvas instead of loose netting, preventing sharks and turtles from becoming entangled beneath the raft, while ensuring the FAD breaks down naturally if lost at sea.

296. (B) Floating objects indicate rich waters
The indicator log hypothesis proposes that pelagic fish associate with FADs because floating objects naturally drift into highly productive ocean convergence zones. In these areas, nutrients accumulate, stimulating rich food webs; thus, fish use the floating object as a visual indicator of food-rich waters to optimize their foraging efficiency.

297. (B) FAD with satellite biomass sensors
A smart FAD is an engineered drifting device equipped with satellite-linked biomass sensors, such as echosounder buoys. This technology allows fishing vessels to monitor the exact quantity and size of the fish aggregated beneath the FAD from hundreds of miles away, optimizing fishing operations and reducing fuel consumption by targeting high-biomass arrays.

298. (B) Small juvenile and forage fishes
The aggregation of marine life around a newly deployed FAD is a successional process where small juvenile and forage fishes typically arrive first. These pioneering species seek immediate shelter beneath the floating structure, subsequently attracting larger predatory pelagic fish like jacks, mahi-mahi, and eventually giant tunas and billfishes to the area.

NODIA

299. (A) FADs facilitate social schooling
The meeting point hypothesis suggests that tunas associate with FADs because the floating structures facilitate social schooling in the vast, featureless open ocean. By acting as a visual and acoustic aggregation point, the FAD helps individual fish locate and join larger schools, enhancing their foraging efficiency and defense against predators.

300. (C) Ghost fishing and marine plastic pollution
The proliferation of lost and abandoned drifting FADs severely exacerbates the global issues of ghost fishing and marine plastic pollution. When these synthetic structures drift unmonitored, their hanging nets continue to entangle and kill marine mammals, sharks, and turtles indefinitely, while their plastic components break down into harmful microplastics.

****

2012

20. Consider the following statements regarding spatial scales of species diversity:

I. Alpha diversity represents local species richness.

II. Beta diversity decreases as habitat heterogeneity increases.

III. Gamma diversity encompasses both alpha and beta components.

IV. High species turnover yields low beta diversity.

Which of the above statements are INCORRECT?

(A) I and III

(B) II and IV

(C) I, II and IV

(D) II, III and IV

2005

21. What happens to beta diversity in a river system heavily impacted by homogenization from invasive species?

(A) It significantly increases

(B) It significantly decreases

(C) It remains unaffected

(D) It fluctuates independent of species composition

2005

22. Which sequence best represents the hierarchical scaling of spatial diversity from smallest to largest geographical area?

(A) Beta, Alpha, Gamma

(B) Alpha, Beta, Gamma

(C) Gamma, Beta, Alpha

(D) Alpha, Gamma, Beta

2005

23. In an oligotrophic lake, alpha diversity of phytoplankton is observed to be low. What is the most plausible ecological reason?

(A) High nutrient availability leading to intense competitive exclusion among species

(B) Extreme physical disturbance and turbulence preventing successful succession

(C) High predation pressure from zooplankton increasing overall species richness

(D) Low nutrient availability restricting the quantity of viable niches

2006

24. Which phenomenon most directly elevates gamma diversity in the Indo-Pacific Coral Triangle?

(A) High regional habitat complexity and historical geological stability

(B) Consistently minimal beta diversity across most major reef systems

(C) Extreme temperature fluctuations causing frequent local extinctions

(D) Severe genetic bottlenecking of several major reef-building coral genera

2007

25. Rarefaction techniques in aquatic biodiversity sampling are primarily used to:

(A) Estimate absolute population sizes of pelagic fishes in offshore environments

(B) Standardize species richness comparisons across samples of varying sizes

(C) Calculate the total biomass of benthic macroinvertebrates in a stream reach

(D) Determine the age structure of a specific fish cohort in a nursery area

2005

26. Which sampling gear is most appropriate for quantitatively assessing demersal fish diversity in a coastal marine environment?

(A) Purse seine

(B) Bottom trawl

(C) Pelagic longline

(D) Plankton net

2015

27. The Chao1 estimator is a non-parametric method used in biodiversity studies to predict:

(A) Total richness based on the count of rare species like singletons

(B) The exact spatial distribution of invasive alien species in coastal zones

(C) The biomass of primary producers in a seasonally productive euphotic zone

(D) The phylogenetic distance between two very closely related aquatic taxa

2022

28. In aquatic macroinvertebrate sampling, what is the primary advantage of a Surber sampler over a kick net?

(A) It allows for efficient sampling in deep, fast-flowing mountain rivers

(B) It provides a highly qualitative assessment of total species presence

(C) It samples a standardized, fixed area of the benthic substrate

(D) It requires no significant physical disruption of the rocky stream bed

2021

29. A species accumulation curve that has reached an asymptote indicates:

(A) The current sampling effort is scientifically

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insufficient for assessment
(B) Further sampling is likely to yield many new and rare aquatic species
(C) The ecosystem is currently experiencing a rapid loss of native biodiversity
(D) The sampling effort has captured the community's total species richness

2018

30. Consider the following statements on biodiversity sampling:
I. Electrofishing is non-selective and highly lethal.
II. Rarefaction curves interpolate data to smaller sample sizes.
III. Extrapolation estimates species richness beyond the sampled dataset.
IV. eDNA sampling detects species presence without physical capture.
V. Gillnets provide unbiased, size-independent fish community samples.
Which of the above statement(s) is/are CORRECT?
(A) I, II and V
(B) II, III and IV
(C) I, III, IV and V
(D) II, IV and V

2021

31. Environmental DNA (eDNA) metabarcoding is revolutionizing aquatic sampling primarily because it:
(A) Directly measures the physiological health of individual fish in the wild
(B) Detects species presence from water samples without physical capture
(C) Provides precise, absolute counts of fish populations in a water body
(D) Determines the exact age of the various organisms in the water column

2019

32. In estimating true species richness, why is the incidence-based Coverage Estimator (ICE) preferred in some aquatic studies over abundance-based estimators?
(A) It requires the exact abundance of every individual in the local community
(B) It only accounts for the highly abundant and dominant species in a sample
(C) It is immune to the sampling biases caused by specific gear selectivity issues
(D) It relies on presence/absence data across multiple sampling units

2017

33. When employing a multi-mesh gillnet for lake biodiversity surveys, the primary goal is to minimize which specific bias?
(A) Size-selective catchability
(B) Species avoidance behavior
(C) Depth-related distribution bias
(D) Seasonal migration patterns

2015

34. Which mathematical interpolation technique is fundamentally used to generate a sample-based rarefaction curve?
(A) Multivariate linear regression analysis
(B) Complex Fourier transformation logic
(C) Monte Carlo resampling without replacement
(D) Standard Principal Component Analysis

2011

35. The Jackknife method for estimating species richness relies heavily on:
(A) The frequency of unique species that occur in only one or two samples
(B) The total biomass of the various organisms in the collected sample
(C) The average total length of the captured fish within the survey area
(D) The ratio of top predators to their prey in the sampled aquatic area

2025

36. Which limitation is most prominent when using hydroacoustic surveys for assessing fish biodiversity?
(A) Inability to sample large geographical areas efficiently and quickly
(B) High mortality rate among surveyed fish due to sound wave pressure
(C) Restriction to extremely shallow and highly turbid inland waters
(D) Difficulty in distinguishing between different fish species

NODIA

2016

37. The Shannon-Weiner index (H') accounts for which two community characteristics?
(A) Species richness and the overall genetic mutation rate
(B) Species richness and relative abundance (evenness)
(C) Species dominance and the total physical habitat size
(D) A combination of alpha diversity and beta diversity scales

2005

38. In the formula for the Shannon-Weiner index, $H' = -\sum p_i \ln p_i$, what does p_i represent?
(A) The total number of species present within the collected sample
(B) The absolute abundance of the most dominant species in the survey
(C) The proportion of individuals belonging to the ith species
(D) The probability of capturing a new species during further sampling

2019

39. Simpson's Diversity Index (D) is heavily weighted towards:
(A) The most rare species in the community
(B) The spatial distribution of the species
(C) The trophic level of the organisms
(D) The most dominant species in the community

2004

40. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): The Shannon-Weiner index is highly sensitive to the addition of rare species in a sample.
Reason (R): The logarithmic function in the Shannon formula disproportionately amplifies the contribution of species with very low relative abundances.
Which of the following is CORRECT?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2007

41. Margalef's richness index (d) is formulated as $d = \frac{S-1}{\ln(N)}$. What does this index primarily attempt to correct for?
(A) The unevenness of species distribution in the habitat
(B) The effect of varying sample sizes
(C) The dominance of a single invasive species in the lake
(D) The genetic diversity within the dominant species groups

2014

42. A community has a Simpson's Index value of 0.8 when formulated as $1 - D$. This indicates:
(A) Very low diversity with one highly dominant species present
(B) High diversity with individuals well distributed among species
(C) A completely homogenous and uniform aquatic ecosystem
(D) Extreme environmental degradation due to pollution

2025

43. Which index is formulated specifically to estimate the probability that two randomly selected individuals from a community belong to the same species?
(A) Simpson's dominance index
(B) Margalef's richness index
(C) Shannon-Weiner entropy index
(D) Chao1 species richness estimator

2019

44. If an aquatic ecosystem is subjected to severe pollution, how will the Shannon-Weiner (H') and Simpson's dominance (D) indices typically respond?
(A) Both H' and D will increase
(B) Both H' and D will decrease
(C) H' will decrease, while D (dominance) will increase
(D) H' will increase, while D (dominance) will decrease

2010

45. While applying diversity indices, researchers often convert the Shannon entropy to "effective number of species" (Hill numbers). The primary advantage of this conversion is that:
(A) It eliminates the need for calculating proportions of each species
(B) It isolates genetic diversity from species diversity measurements
(C) It requires only presence-absence data for various aquatic taxa
(D) It behaves linearly, allowing intuitive comparisons of diversity

2018

46. Identify the INCORRECT statement regarding Margalef's index.
(A) It depends heavily on the total number of individuals sampled
(B) It assumes a linear relationship between species number and the logarithm of population size
(C) It accounts perfectly for species evenness
(D) It is an index of species richness rather than heterogeneity

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2025

86. Marine organisms like sponges and tunicates are prime targets for bioprospecting because they:
(A) Produce novel secondary metabolites as defense mechanisms
(B) Grow significantly faster than most known terrestrial plants
(C) Possess skeletons made entirely of pure and durable silica
(D) Are highly mobile organisms and therefore easy to farm in tanks

2012

87. Ziconotide, a potent analgesic drug, was commercially developed through bioprospecting the venom of which marine organism?
(A) Cone snails (Conus spp.)
(B) Pufferfish (Tetraodontidae)
(C) Box jellyfish (Cubozoa)
(D) Blue-ringed octopus (Hapalochlaena)

2021

88. Extremozymes used in molecular biology, such as Taq polymerase, originally highlight the bioprospecting value of organisms found in:
(A) Complex Coral reefs and associated systems
(B) Deep-sea hydrothermal vents and hot springs
(C) Brackish Mangrove swamps and tidal regions
(D) Nutrient-rich Estuarine mudflats and deltas

2019

89. Which property makes marine macroalgae highly valued in bioprospecting for the food and cosmetic industries?
(A) Production of unique phycocolloids like agar and alginate
(B) High concentrations of various potent neurotoxins
(C) Complete lack of pigmentation in all cell layers
(D) Inability to synthesize vitamins for human health

2013

90. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): Marine sponges are frequently associated with the discovery of novel pharmaceutical compounds.
Reason (R): Sponges host vast and diverse symbiotic microbial communities that synthesize many of these bioactive secondary metabolites.
Which of the following is CORRECT?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2008

91. The primary aim of "valuation" in aquatic bioprospecting is to:
(A) Sell conservation areas to private developers for commercial gain
(B) Determine economic and ecological worth of resources to justify conservation
(C) Establish market prices for all common commercial fish catches
(D) Tax indigenous communities for utilizing biological resources locally

2022

92. Which compound derived from the horseshoe crab is highly valued in the biomedical industry for endotoxin testing?
(A) Tetrodotoxin
(B) Limulus amebocyte lysate (LAL)
(C) Astaxanthin
(D) Chitin

2008

93. Green Fluorescent Protein (GFP), a crucial biomarker in molecular biology, was isolated via bioprospecting from which marine animal?
(A) Aequorea victoria (jellyfish)
(B) Hippocampus (seahorse)
(C) Acanthaster planci (crown-of-thorns starfish)
(D) Physalia physalis (Portuguese man o' war)

2012

94. Commercialization of aquatic genetic resources must navigate the risk of overharvesting. Which method is the preferred sustainable alternative to wild harvesting of marine biochemicals?
(A) Intense bottom trawling in deep oceanic waters
(B) Cyanide fishing in sensitive coral reef systems
(C) Chemical synthesis and marine microbial fermentation
(D) Destructive blast fishing in coastal zones

2004

95. Astaxanthin, a powerful antioxidant widely commercialized in human supplements and aquaculture feeds, is naturally hyper-accumulated by which aquatic organism?
(A) Haematococcus pluvialis (microalga)
(B) Caulerpa taxifolia (invasive macroalga)
(C) Lates calcarifer (commercial barramundi)
(D) Crassostrea gigas (Pacific oyster species)

NODIA

(D) Infinity

2024

56. Which ecological scenario most directly reduces species evenness in a lentic ecosystem?
(A) Algal bloom of a toxic cyanobacteria species
(B) Symmetrical predation on all species in the pond
(C) Uniform distribution of various microhabitats in the area
(D) Complete elimination of all invasive aquatic species

2005

57. Compared to Pielou's index, Simpson's measure of evenness ($E_{\frac{1}{D}}$) is generally:
(A) More sensitive to species richness variations among sampled habitats
(B) Less sensitive to species richness and independent of rare species
(C) Highly reliant on the presence of singletons in the collected data
(D) Incapable of reaching a maximum theoretical value of 1 in any case

2024

58. Assessing both dominance and evenness is critical in aquatic ecology because two habitats can have the same species richness but function differently if:
(A) They have identical genetic diversity across all populations present
(B) One is dominated by a few species while the other is evenly distributed
(C) They are located at significantly different latitudes and longitudes
(D) They experience the exact same water flow regime throughout the year

2016

59. The relationship between dominance and diversity can be characterized generally as:
(A) Inversely proportional
(B) Directly proportional
(C) Completely independent
(D) Exponentially positive

2013

60. Arrange the following steps to calculate Pielou's Evenness Index:
I. Determine the maximum possible diversity ($H_{\max}$).
II. Count the total number of species (S).
III. Calculate the Shannon-Weiner Index (H').
IV. Divide H' by $H_{\max}$.
(A) II → III → I → IV
(B) III → II → I → IV
(C) I → II → IV → III
(D) II → I → III → IV

2008

61. Paleo-endemism in aquatic fauna refers to:
(A) Species formerly widespread but now restricted to a localized area
(B) Species that have recently evolved in an isolated aquatic habitat
(C) Endemic species introduced by various historical human activities
(D) Extinct species found only in ancient fossil records of the region

2021

62. Which fish genus is a prominent example of paleo-endemism found in the subterranean aquatic habitats of the Western Ghats?
(A) Tor
(B) Channa
(C) Labeo
(D) Kryptoglanis

2018

63. Neo-endemism is ecologically driven primarily by:
(A) Glacial retreats isolating ancient populations from their ancestors
(B) Rapid recent speciation due to isolation and divergent adaptation
(C) Widespread extinction of related taxa in the surrounding regions
(D) Long-distance oceanic migrations into new and isolated basins

2010

64. The blind swamp eel (Rakthamichthys rongsaw) is a notable cave-dwelling endemic species native to which Indian region?
(A) Western Ghats
(B) Andaman and Nicobar Islands
(C) Eastern Ghats
(D) North-East India (Meghalaya)

2008

65. The Western Ghats is a hotspot for endemic freshwater fish. Which family exhibits a high degree of endemism in the fast-flowing streams of this region?
(A) Cyprinidae (e.g., Denison barb)
(B) Cichlidae (e.g., Nile tilapia)
(C) Salmonidae (e.g., Brown trout)
(D) Pangasiidae (e.g., Striped catfish)

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2010

47. Which mathematical property makes the Simpson index robust against sample size variations in large datasets?
(A) Its reliance on the presence of rare species singletons
(B) Its focus on the variance of relative abundance distribution
(C) Its independence from the total number of species present
(D) Its conversion of raw counts into various logarithmic bases

2009

48. In a heavily managed aquaculture pond containing only Carp, the Shannon-Weiner diversity index would theoretically be:
(A) Infinite
(B) 1.0
(C) -1.0
(D) 0.0

2023

49. Pielou's Evenness Index (J') is mathematically derived from which diversity index?
(A) Shannon-Weiner index
(B) Simpson's index
(C) Margalef's index
(D) Brillouin index

2013

50. Match the diversity indices in List I with their core mathematical descriptions in List II.
List I: (Diversity Index)
P. Shannon-Weiner
Q. Simpson's Index
R. Pielou's Index
S. Margalef's Index
List II: (Description)
1. Ratio of observed diversity to maximum possible diversity
2. Evaluates probability of intra-specific encounters
3. Focuses on information entropy and rare species
4. Adjusts species richness by natural log of total individuals
(A) P-3, Q-2, R-1, S-4
(B) P-2, Q-3, R-4, S-1
(C) P-1, Q-4, R-2, S-3
(D) P-3, Q-1, R-4, S-2

2004

2017

51. The formula for Pielou's evenness is $J' = \frac{H\hat{a}\in^{TM}}{\ln(S)}$. What does $\ln(S)$ represent in this context?
(A) The maximum possible Shannon diversity
(B) The absolute abundance of the collected sample
(C) The minimum possible diversity of the community
(D) The dominance threshold of the aquatic community

2025

52. A Pielou's Evenness value of 0.95 in a benthic community indicates that:
(A) One species heavily dominates the entire aquatic community
(B) The community has very low species richness in the survey
(C) The sampling effort was inadequate to capture the population
(D) The individuals are distributed highly evenly among the species

2006

53. Berger-Parker Dominance Index is simplest to calculate because it only requires:
(A) The total number of species present in the sampled community
(B) The relative abundance of the single most abundant species
(C) The specific proportion of rare species in the sample
(D) The total biomass of the entire aquatic ecosystem being studied

NODIA

2017

54. High species dominance in a natural aquatic ecosystem often suggests:
(A) High ecological resilience against significant disturbances
(B) A pristine, undisturbed habitat with very high biodiversity
(C) Environmental stress or enrichment favoring opportunistic taxa
(D) Maximum resource partitioning among specialized aquatic species

2007

55. If all species in a community have the exact same number of individuals, Pielou's Evenness index will equal:
(A) 0
(B) 0.5
(C) 1.0

2012

76. Which benthic macroinvertebrate family is typically considered highly tolerant to organic pollution and hypoxia (often scoring low in biological indices)?
(A) Chironomidae (Non-biting midges)
(B) Perlidae (Stoneflies)
(C) Heptageniidae (Mayflies)
(D) Hydropsychidae (Net-spinning caddisflies)

2015

77. Periphyton is used in aquatic biomonitoring primarily to assess:
(A) Nutrient enrichment and heavy metal bioaccumulation
(B) Predation rates by top-tier piscivores in the food web
(C) Long-term accumulation of microplastics in the river system
(D) Spawning success of anadromous fishes in their home streams

2018

78. The Biological Monitoring Working Party (BMWP) score system assigns numerical values to macroinvertebrate families based on their:
(A) Commercial economic value
(B) Tolerance to organic pollution
(C) Absolute size and biomass
(D) Genetic heterozygosity

2003

79. In a river segment showing a massive dominance of Tubificid worms (Oligochaeta) and near absence of EPT taxa, the most likely environmental stressor is:
(A) Organic loading from untreated sewage
(B) High acidity from acid rain
(C) Thermal pollution from a nuclear plant
(D) Agricultural pesticide runoff

2022

80. What is a key disadvantage of relying solely on physical and chemical water testing compared to biomonitoring?
(A) Chemical testing provides continuous and historical exposure data
(B) Chemical testing cannot detect dissolved oxygen in most water bodies
(C) Chemical testing requires no specialized equipment or trained staff
(D) Chemical testing only provides a 'snapshot' of conditions

2025

81. The term "Autotrophic Index" in periphyton analysis evaluates the ratio of:
(A) Biomass (Ash-Free Dry Weight) to Chlorophyll-a
(B) Dissolved Oxygen to Biochemical Oxygen Demand
(C) Cyanobacteria to Diatoms
(D) Primary producers to primary consumers

2001

82. Which statement regarding the EPT index is CORRECT?
(A) A decrease in the EPT index indicates an improvement in stream health
(B) EPT taxa are generally found in lentic and highly turbid environments
(C) The index counts the number of taxa in three sensitive insect orders
(D) Trichoptera are the most pollution-tolerant of all aquatic organisms

2016

83. The River Invertebrate Prediction and Classification System (RIVPACS) is utilized to:
(A) Compare observed macroinvertebrate fauna with expected pristine fauna
(B) Predict the future spread of various invasive fish species in a basin
(C) Model the complex hydrology of dam releases and their flow impacts
(D) Calculate the exact age of benthic organisms using carbon dating

2004

84. Which periphyton group is highly sensitive to changes in water pH and is widely used for paleolimnological reconstructions of lake acidification?
(A) Diatoms (Bacillariophyta)
(B) Filamentous Cyanobacteria
(C) Common Green algae (Chlorophyta)
(D) Stable Red algae (Rhodophyta)

2023

85. Bioprospecting in aquatic environments involves:
(A) Systematic search for biochemical and genetic information in nature
(B) Mining the seabed for precious metals and various rare earth elements
(C) Surveying deep sea trenches for undiscovered oil and gas reserves
(D) Catching wild broodstock for traditional and commercial aquaculture

NODIA

2011

105. Mutually Agreed Terms (MAT) under the Nagoya Protocol specifically govern:
(A) The specific timeline for mandatory environmental impact assessments
(B) The annual quotas for various commercial fishing operations in the zone
(C) The strict and total prohibition of all commercial biological patents
(D) Conditions of access and how benefits will be shared between parties

2023

106. Under the TRIPS agreement, which organism type is strictly excluded from patentability to protect public interest, though microorganisms may be patented?
(A) Genetically modified bacteria used for industrial fermentation
(B) Synthetically produced DNA sequences for medical research
(C) Cell lines derived from bioprospecting in deep sea environments
(D) Plants and animals naturally occurring in the wild

2017

107. Which action constitutes a classic example of biopiracy involving aquatic resources?
(A) A university publishing a comprehensive taxonomic review of new fish species
(B) Patenting a marine compound using indigenous knowledge without benefit-sharing
(C) A local fishing cooperative securing regional geographical indication (GI) rights
(D) Establishing a Marine Protected Area (MPA) restricting all resource extraction

2002

108. Under the TRIPS agreement, which organism type is strictly excluded from patentability to protect public interest, though microorganisms may be patented?
(A) Genetically modified bacteria used for industrial fermentation
(B) Synthetically produced DNA sequences for medical research
(C) Cell lines derived from bioprospecting in deep sea environments
(D) Plants and animals naturally occurring in the wild

2001

109. How does temperature primarily affect the dissolved oxygen (DO) capacity of an aquatic ecosystem?
(A) As temperature increases, DO capacity increases
(B) As temperature increases, DO capacity decreases
(C) Temperature has no effect on DO capacity
(D) DO capacity is entirely dependent on pH, not temperature

2012

110. Consider the following statements regarding critical environmental parameters:
I. Salinity strongly influences the osmoregulatory energy expenditure of fish.
II. Low pH in water increases the toxicity of heavy metals like aluminum.
III. High water temperature decreases fish metabolic rates.
Which of the above statement(s) is/are CORRECT?
(A) I and III
(B) II and III
(C) I and II
(D) I only

2023

111. The phenomenon where a fish species occupies a specific spatial depth in a lake due to an abrupt temperature gradient is linked to the:
(A) Thermocline
(B) Halocline
(C) Chemocline
(D) Pycnocline

2001

112. Un-ionized ammonia (NH3) is highly toxic to fish. Its proportion relative to non-toxic ammonium (NH4+) increases significantly when:
(A) Both pH and temperature decrease
(B) pH increases and temperature increases
(C) Salinity increases and pH decreases
(D) Dissolved oxygen increases

2016

113. An extreme drop in dissolved oxygen (hypoxia) typically triggers which primary behavioral response in freshwater fish?
(A) Persistent benthic resting behavior
(B) Immediate and premature spawning
(C) Hyperphagia (increased feeding rate)
(D) Aquatic surface respiration

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2001

96. What makes deep-sea sponges from the genus Euplectella of interest to materials science bioprospecting?
(A) Their brilliant and signaling bioluminescence
(B) Silica structures resembling commercial fiber optics
(C) Their ability to produce natural crude oil in cells
(D) Their extremely rapid reproductive and growth cycles

2008

97. Biopiracy is most accurately defined as:
(A) Unauthorized appropriation of biological resources and traditional knowledge
(B) The illegal harvesting of endangered fish species in international waters
(C) The physical piracy and boarding of various fishing vessels
(D) The introduction of invasive species into a non-native aquatic ecosystem

2008

98. The Convention on Biological Diversity (CBD) was opened for signature during which major international event?
(A) The Earth Summit in Rio de Janeiro (1992)
(B) The Kyoto Protocol Conference (1997)
(C) The Stockholm Conference (1972)
(D) The Paris Agreement Summit (2015)

2003

99. Which mechanism is mandated by the CBD to prevent biopiracy?
(A) Total ban on biological research
(B) Access and Benefit Sharing (ABS)
(C) Free open-access to all genetic resources
(D) Exclusive monopolization by multinational corporations

2013

100. Match the intellectual property and conservation treaties in List I with their core objectives in List II.
List I: (Treaty)
P. Nagoya Protocol
Q. TRIPS Agreement
R. CITES
S. CBD
List II: (Objective)
1. Establishes minimum standards for intellectual property regulation globally
2. Regulates international trade in endangered species
3. Provides a transparent legal framework for Access and Benefit Sharing
4. Commits to conservation, sustainable use, and equitable benefit sharing
(A) P-3, Q-1, R-2, S-4
(B) P-4, Q-2, R-1, S-3
(C) P-1, Q-4, R-2, S-3
(D) P-3, Q-2, R-4, S-1

2024

101. Prior Informed Consent (PIC) under the Nagoya Protocol requires that:
(A) Researchers must obtain permission from provider country and communities
(B) Researchers must inform consumers about the biochemical content of products
(C) Patents must be officially granted before any research begins on the site
(D) All research data must be published immediately in open-access journals

2008

102. Intellectual Property Rights (IPR) disputes in aquaculture often center around:
(A) The exact geographical coordinates of various commercial fishing zones
(B) Patenting of selectively bred or genetically modified fish strains
(C) The legal right to navigate through Exclusive Economic Zones of nations
(D) The standardization of net mesh sizes for commercial shrimp trawlers

2012

103. Traditional Ecological Knowledge (TEK) is highly vulnerable to biopiracy because:
(A) Frequently held in public domain or passed down orally without patent
(B) It is rigorously and strictly protected by international patent law
(C) It has no practical or commercial application in modern science
(D) It is easily synthesized in high-tech laboratories without a source

NODIA

2014

104. Which concept establishes that states have sovereign rights over their own biological resources?
(A) Sovereign Rights Doctrine (as affirmed by the CBD)
(B) Tragedy of the Commons
(C) Common Heritage of Mankind
(D) Freedom of the Seas

2006

66. Identify the INCORRECT pair regarding endemic fish and their primary native region in India.
(A) Sahyadria denisonii - Western Ghats
(B) Channa aurantimaculata - North-East India (Brahmaputra basin)
(C) Horabagrus brachysoma - Kerala backwaters
(D) Tor putitora - Coromandel Coast estuaries

2025

67. Adaptive radiation resulting in a cluster of closely related neo-endemic species is most famously observed in which global aquatic ecosystem?
(A) Cichlids in the African Rift Lakes
(B) Salmonids in the North Atlantic
(C) Cyprinids in the Ganges River
(D) Sturgeons in the Caspian Sea

2024

68. Which factor is least likely to promote the evolution of endemism in a freshwater aquatic ecosystem?
(A) High hydrological connectivity to major global oceans
(B) Geographical isolation by mountain ranges
(C) Stable microclimates over evolutionary time
(D) Unique geological substrates and water chemistry

2018

69. The Golden Mahseer (Tor putitora) is endemic to the Himalayan foothills. What represents the most significant current threat to its endemic habitats?
(A) Global sea-level rise impacting inland freshwater ecosystems
(B) River damming and hydroelectric projects altering flow regimes
(C) Overfishing by massive oceanic trawlers in the deep sea
(D) Introduction of various marine invasive species to river systems

2022

70. Arrange the following events to explain the formation of paleo-endemic aquatic species:
I. Extinction of the species in the broader surrounding geographical areas.
II. A once widespread species occupies a vast continuous aquatic network.
III. The species survives as a relict population in a restricted, isolated refuge.
IV. Geological or climatic changes fragment the continuous habitat.
(A) II → IV → I → III
(B) IV → II → III → I
(C) II → I → IV → III
(D) I → II → IV → III

2003

71. North-East India is considered a freshwater biodiversity hotspot. Which river basin constitutes the primary drainage network supporting its high endemic fish fauna?
(A) Brahmaputra basin
(B) Godavari basin
(C) Narmada basin
(D) Cauvery basin

2017

72. Which term describes endemic species whose exact point of evolutionary origin is identical to their current restricted distribution?
(A) Autochthonous endemics
(B) Allochthonous endemics
(C) Eurytopic endemics
(D) Pandemic endemics

2010

73. Biological monitoring using benthic macroinvertebrates is highly effective because they:
(A) Have very short life cycles (hours to days), showing immediate pollution effects
(B) Are highly mobile and easily evade localized pollution plumes
(C) Rely completely on terrestrial food webs
(D) Are relatively sedentary and reflect long-term site-specific water quality

2009

74. In aquatic biomonitoring, what does the EPT index represent?
(A) Ephemeroptera, Plecoptera, Trichoptera
(B) Eutrophication, Phytoplankton, Temperature
(C) Estuarine Pollution Tolerance
(D) Environmental Phosphorous Tracking

2011

75. High abundance of organisms belonging to the orders Ephemeroptera, Plecoptera, and Trichoptera in a stream indicates:
(A) High water quality with high dissolved oxygen
(B) Severe organic pollution and persistent anoxia in the system
(C) Extreme heavy metal contamination in the sediment layers
(D) High levels of salinity and turbidity in the water column

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2019

114. How does elevated salinity in an estuary dictate the spatial distribution of stenohaline freshwater fish?

(A) It encourages their rapid migration into the open marine ocean
(B) Forms a physiological barrier, restricting them to low-salinity reaches
(C) It stimulates them to alter their diet to marine invertebrates
(D) It rapidly converts them into highly euryhaline fish species

2017

2016

115. A highly acidic aquatic environment ($pH < 5$) directly impairs fish survival primarily by causing:

(A) Significantly increased digestion rates in cold water
(B) Gill damage, mucus secretion, and osmoregulatory failure
(C) Excessive and rapid bone calcification in the fish
(D) Increased visual acuity for finding prey in dark water

2008

116. Stenothermal fish species, like trout, are ecologically characterized by:

(A) A wide tolerance to temperature fluctuations
(B) A strict requirement for warm, tropical waters
(C) A narrow range of temperature tolerance
(D) An ability to switch between endothermy and ectothermy

2023

117. Euryhaline species, such as the Bull Shark or Asian Seabass, are uniquely adapted to:

(A) Survive extreme and prolonged hypoxia in stagnant inland ponds
(B) Withstand salinity fluctuations, migrating between fresh and marine waters
(C) Breed exclusively in the highly acidic peat swamps of the tropics
(D) Tolerate water temperatures frequently exceeding 40°C in the wild

2018

118. In terms of spatial distribution, why do many marine pelagic fish vertically migrate to deeper waters during the day?

(A) To maximize their exposure to UV radiation during the day
(B) To escape high surface temperatures and visual predators
(C) To find highly oxygenated surface water for respiration
(D) To locate specific low-salinity currents in the deep ocean

2017

119. Oxygen sag curves in a river profile are typically driven by the interplay of dissolved oxygen, microbial respiration, and which environmental factor?

(A) Biochemical Oxygen Demand (BOD) from organic pollution
(B) Heavy metal precipitation
(C) Atmospheric nitrogen deposition
(D) Extreme alkalinity

NODIA

2015

120. Consider the following parameters regarding aquatic environments:

I. Temperature regulates biochemical reaction rates in ectotherms.
II. Alkalinity serves as a buffer against rapid pH changes.
III. High dissolved carbon dioxide increases water pH.
IV. The solubility of oxygen decreases at higher salinities.

Which of the above statement(s) is/are CORRECT?

(A) I, II and IV
(B) I, II and III
(C) II, III and IV
(D) I, III and IV

2006

121. Ecological resilience in an aquatic system is defined as its capacity to:

(A) Maintain absolute stability with zero population fluctuations over time
(B) Absorb disturbances and reorganize while retaining basic structure
(C) Rapidly undergo a regime shift to a fundamentally different state
(D) Maximize resource extraction indefinitely for economic purposes

2024

122. A "tipping point" in marine ecology refers to:

(A) The optimal temperature required for mass coral spawning events
(B) The geographic boundary between two major global oceanic currents
(C) Threshold where small perturbation

2013

161. Thermal pollution from industrial cooling water discharge most directly impacts aquatic ecosystems by:
(A) Significantly increasing dissolved oxygen saturation in water
(B) Altering metabolic rates, premature spawning, and localized hypoxia
(C) Completely freezing the various benthic substrates of the river
(D) Reducing the overall toxicity of the existing heavy metals

2006

162. Eutrophication driven by agricultural phosphorus runoff leads to massive fish kills primarily through:
(A) The physical clogging of fish gills by massive algal mats
(B) The direct toxicity of phosphorus levels to adult fish species
(C) Oxygen depletion from microbial decomposition of dying algae
(D) The rapid and permanent increase in water pH to basic levels

2019

163. The synergistic threat of pollution and habitat fragmentation severely restricts a fish species' ability to:
(A) Interbreed with marine mammals in the coastal environment
(B) Digest artificial and commercial aquaculture feeds in the wild
(C) Efficiently regulate internal body temperature in cold waters
(D) Shift geographical range to escape localized toxic zones

2022

164. Which of the following is an indirect consequence of overfishing herbivorous coral reef fishes (e.g., parrotfish)?
(A) Phase shift of the reef from coral-dominated to macroalgae-dominated
(B) Significantly accelerated growth of branching coral species
(C) Rapid and massive increase in sea urchin predation by fish
(D) Significant decrease in oceanic dissolved carbon dioxide levels

2003

165. The construction of run-of-the-river hydroelectric projects in the Himalayas uniquely alters aquatic habitats by:
(A) Bypassing natural channels through tunnels, leaving stretches dry
(B) Creating massive and extremely deep-water reservoirs for storage
(C) Permanently reversing the natural direction of the river flow
(D) Introducing marine salinity into high-altitude freshwater streams

2007

166. Point-source pollution is distinguished from non-point source pollution by being:
(A) Driven entirely by widespread agricultural runoff
(B) Exclusive to atmospheric deposition of heavy metals
(C) Impossible to regulate or monitor
(D) Originating from a single, identifiable source, such as a factory effluent pipe

2008

167. Microplastic pollution in aquatic food webs demonstrates "biomagnification," which is the process where:
(A) Concentration of toxins on plastics increases at higher trophic levels
(B) Microplastics degrade into harmless monomers at higher trophic levels
(C) Primary producers expel all plastics back into the water column
(D) Filter feeders safely and efficiently sequester all plastic particles

2005

168. Destructive fishing practices such as bottom trawling severely impact aquatic biodiversity by:
(A) Capturing only the specific target and valuable commercial species
(B) Enhancing the structural complexity of the benthic marine habitat
(C) Destroying benthic habitats and generating massive unselective bycatch
(D) Significantly oxygenating the sediment layer through disturbance

2004

169. An Invasive Alien Species (IAS) is defined as a non-native species that:
(A) Non-native species causing harm or threatening health in new environments
(B) Fails to establish a viable or self-sustaining population in the wild
(C) Is introduced exclusively via natural and predictable climatic events
(D) Enhances the total native biodiversity of the

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2025
132. The "Portfolio Effect" in aquatic ecology contributes to resilience by:
(A) Concentrating all biomass in a single, highly productive fish species
(B) Restricting genetic flow between adjacent and connected habitats
(C) Promoting uniform age structures in all commercial fish stocks
(D) Diverse, asynchronous dynamics of multiple subpopulations

2011
133. A keystone species is defined as a species that:
(A) Has the highest total biomass in the entire aquatic ecosystem
(B) Disproportionately large environmental impact relative to abundance
(C) Is specifically targeted for international conservation funding
(D) Only exists in highly specialized and isolated microhabitats

2001
134. Which organism is classically identified as a keystone species in kelp forest ecosystems due to its regulation of sea urchin populations?
(A) Great White Shark
(B) Sea Otter
(C) California Sea Lion
(D) Pacific Walrus

2019
135. The Ganges River Dolphin (Platanista gangetica) is frequently utilized in conservation campaigns to generate public support and funding for river conservation. It functions primarily as a:
(A) Keystone species
(B) Umbrella species
(C) Flagship species
(D) Invasive species

2017
136. An "umbrella species" is chosen for conservation planning because:
(A) Its protection indirectly protects many other species in the habitat
(B) It possesses a rigid, shell-like structure protecting it from predators
(C) It is the sole primary producer in the regional aquatic ecosystem
(D) It only migrates during the monsoon season for breeding purposes

2007
137. Which characteristic makes the Golden Mahseer an effective umbrella species for Himalayan river ecosystems?
(A) It requires a very small, highly polluted and localized habitat
(B) It is completely independent of the benthic food web in rivers
(C) It feeds exclusively on terrestrial vegetation along the banks
(D) Requires extensive, connected, and pristine river networks

2008
138. Indicator species are predominantly utilized to:
(A) Infer the environmental condition or health of a specific habitat
(B) Represent the maximum theoretical biodiversity of a region
(C) Eradicate invasive alien species
(D) Commercialize biochemical derivatives

2014
139. In the context of a surrogate species, what is a primary limitation of relying entirely on flagship species for conservation?
(A) Their habitat needs may not perfectly overlap with cryptic or specialized endemic species
(B) They are always the cheapest and easiest species to monitor
(C) They cannot be legally protected under any international law
(D) They prevent the funding of any other species in the ecosystem

NODIA

2001
140. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): Protecting the habitat of a widely ranging umbrella species guarantees the survival of all endemic species within that region.
Reason (R): Umbrella species invariably share the exact microhabitat requirements and environmental tolerances of every sympatric species.
Which of the following is CORRECT?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2012
179. The biological mechanism where an invasive species introduces a novel pathogen to which native species have no immunity is known as:
(A) Pathogen pollution / Enemy release
(B) Genetic introgression
(C) Competitive exclusion
(D) Sympatric speciation

2018
180. The widespread introduction of Common Carp (Cyprinus carpio) alters benthic aquatic habitats primarily by:
(A) Building extensive and complex coral-like reef structures
(B) Bioturbation; uprooting plants and increasing turbidity while foraging
(C) Secreting chemicals that kill all native submerged plants in ponds
(D) Consuming exclusively microscopic and beneficial phytoplankton

2014
181. Norman Myers formulated the concept of global biodiversity hotspots in 1988 based primarily on which two quantitative criteria?
(A) High levels of plant endemism and significant habitat loss
(B) High levels of genetic diversity and large geographic area
(C) High numbers of large charismatic megafauna and lack of human presence
(D) Extreme climatic stability and high beta diversity

2004
182. According to the updated Conservation International criteria, to qualify as a global biodiversity hotspot, a region must contain at least 1,500 species of vascular plants as endemics and:
(A) Must have gained at least 10% new habitat area via restoration
(B) Must have lost at least 70% of its original native habitat
(C) Must be located strictly within the tropical climatic zones
(D) Must encompass both marine and terrestrial ecosystems in one

2008
183. Which of the following is officially recognized as a global biodiversity hotspot encompassing critical Indian aquatic ecosystems?
(A) The Western Ghats and Sri Lanka
(B) The Thar Desert
(C) The Deccan Plateau
(D) The Ganges River Delta

2005
184. Indo-Burma is a major biodiversity hotspot that covers parts of North-East India. Which iconic freshwater river system is central to this hotspot's aquatic diversity?
(A) Godavari River
(B) Indus River
(C) Narmada River
(D) Mekong River and Brahmaputra River systems

2025
185. In conservation biology, the "SLOSS" debate refers to the design of protected areas and stands for:
(A) Sustainable Landscapes Or Strict Sanctuaries
(B) Single Large Or Several Small
(C) Save Local Organisms and Surrogate Species
(D) Spatial Layout Of Species Survival

2025
186. Which region is often designated as a "Marine Biodiversity Hotspot" due to possessing the highest global diversity of hermatypic corals and reef-associated fishes?
(A) The Sargasso Sea
(B) The Caribbean Sea
(C) The Coral Triangle (Indo-Pacific)
(D) The Great Barrier Reef

2011
187. Sundaland, another hotspot partially encompassing the Andaman and Nicobar Islands, is highly threatened by which activity impacting its aquatic margins?
(A) Expansion of oil palm plantations and mangrove clearance
(B) Geothermal energy extraction from deep volcanic ridges
(C) Widespread glacial melting in high altitude regions
(D) Deep sea manganese nodule mining in the open ocean

2010
188. Why are freshwater ecosystems frequently considered more imperiled than terrestrial ecosystems within global hotspots?
(A) They have naturally lower speciation rates than terrestrial zones
(B) They lack distinct and recognizable geographical boundaries
(C) They possess zero endemic species according

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2018
151. Osteobrama belangeri (Pengba) is a highly prized endemic fish and the State Fish of Manipur. Its population in Loktak Lake declined drastically primarily due to:
(A) Severe ocean acidification impacting the freshwater lake
(B) Ithai Barrage preventing its potamodromous migration
(C) Overpredation by the various Ganges River Dolphin populations
(D) Extreme heavy metal toxicity from industrial mining operations

2005
152. The State Fish of Andhra Pradesh, highly valued in aquaculture, is:
(A) Catla catla
(B) Labeo rohita
(C) Penaeus monodon (Tiger shrimp)
(D) Channa striata (Murrel)

2010
153. Which state designated the 'Chocolate Mahseer' (Neolissochilus hexagonolepis) as its State Fish?
(A) Gujarat
(B) Nagaland
(C) Punjab
(D) Rajasthan

2016
154. What is a primary legal and policy benefit of declaring a specific species as a "State Fish"?
(A) It permanently and strictly prevents any fishing of the species
(B) Triggers targeted funding, restoration, and awareness programs
(C) It immediately removes the species from the IUCN Red List
(D) It allows the state to export the fish globally without federal oversight

2009
155. The declaration of 'Ghol' (Protonibea diacanthus) as a State Fish in 2023 was made by which Indian state?
(A) Maharashtra
(B) Gujarat
(C) Goa
(D) Karnataka

2012
156. The State Fish of Uttar Pradesh is Chitala chitala. What is its common name?
(A) Indian Major Carp
(B) Giant River Catfish
(C) Snakehead Murrel
(D) Clown Knifefish / Moy

2009
157. Habitat fragmentation in lotic (riverine) ecosystems is most severely caused by:
(A) River damming and barrage construction
(B) Seasonal monsoons
(C) Overfishing using gillnets
(D) Introduction of exotic ornamental plants

2024
158. How do dams primarily threaten the populations of anadromous fishes like Hilsa?
(A) By significantly decreasing the salinity of the open ocean
(B) Blocking migration routes to freshwater spawning grounds
(C) By increasing the turbidity of the lower reaches of the estuary
(D) By accelerating the flow velocity beyond their swimming capacity

2011
159. Overexploitation of aquatic biodiversity typically follows the "Fishing down the marine food web" concept, which means:
(A) Targeting lower trophic levels as high-trophic predators are depleted
(B) Fisheries exclusively harvest benthic and deep-water species
(C) Fisheries only catch fish in the deep and remote ocean zones
(D) Catch rates increase perpetually with the use of modern technology

2025
160. Arrange the anthropogenic impacts in the sequence they typically degrade an unexploited river ecosystem:
I. Overharvesting of large keystone predator species.
II. Introduction of non-native species for enhanced fishery yield.
III. Dam construction altering flow regimes and fragmenting habitats.
IV. Agricultural intensification causing severe eutrophication.
(A) III → I → IV → II
(B) I → III → IV → II
(C) I → IV → II → III
(D) IV → I → III → II

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(B) 70%
(C) 90%
(D) 100%

2017
198. An aquatic species data lacks sufficient information on abundance or distribution to make a direct or indirect assessment of its risk of extinction. The correct IUCN category is:
(A) Data Deficient (DD)
(B) Not Evaluated (NE)
(C) Least Concern (LC)
(D) Lower Risk (LR)

2025
199. Criterion E of the IUCN Red List relies on Quantitative Analysis. The most common ecological modeling tool used for this criterion is:
(A) Population Viability Analysis (PVA)
(B) Geographic Information Systems (GIS) mapping
(C) Maximum Sustainable Yield (MSY) calculation
(D) Genetic barcoding

2019
200. Match the IUCN Red List categories in List I with their defining conditions in List II.
List I: (Category)
P. Least Concern (LC)
Q. Near Threatened (NT)
R. Vulnerable (VU)
S. Endangered (EN)
List II: (Condition)
1. Facing a very high risk of extinction in the wild
2. Close to qualifying for a threatened category in the near future
3. Facing a high risk of extinction in the wild
4. Widespread and abundant taxa
(A) P-4, Q-2, R-3, S-1
(B) P-3, Q-1, R-4, S-2
(C) P-4, Q-3, R-2, S-1
(D) P-2, Q-4, R-1, S-3

2002
201. Which term describes the IUCN variable defined as "the total number of mature individuals capable of reproduction"?
(A) Effective population size
(B) Biomass
(C) Population size
(D) Fecundity rate

2022
202. The "generation length" used in IUCN assessments is important because:
(A) Scales the timeframe for population reduction to life history
(B) It determines the exact age a fish is allowed to be harvested locally
(C) It standardizes the physical length of all aquatic species in surveys
(D) It calculates the total biomass turnover rate of the ecosystem

2010
203. Which scenario directly triggers an assessment under Criterion C of the IUCN framework?
(A) A massive sudden drop in water quality without immediate population data
(B) A heavily fragmented geographic range with an EOO less than 100 sq km
(C) Small population size combined with an ongoing decline
(D) High commercial value in international trade for ornamental purposes

2015
204. "Not Evaluated" (NE) is an IUCN category applied when:
(A) A species has not yet been evaluated against the IUCN criteria
(B) A species has been assessed but rejected from the list
(C) The species is known to be extinct but lacks fossil evidence
(D) A species occurs exclusively in privately owned aquaculture ponds

2022
205. The primary objective of a Conservation Assessment and Management Plan (CAMP) workshop is to:
(A) Evaluate regional taxa using IUCN criteria and propose actions
(B) Draft various international treaties for the global fish trade
(C) Distribute fishing quotas among competing commercial fleets and nations
(D) Synthesize new and valuable chemical compounds from marine organisms

NODIA

2021
206. A key tool utilized during CAMP workshops for facilitating decisions on species categorization and management is the:
(A) Taxon Data Sheet
(B) Commercial Catch Logbook
(C) Vessel Monitoring System

host aquatic ecosystem

2016

170. Arrange the progressive stages of biological invasion by an alien aquatic species:
I. Establishment of a self-sustaining population.
II. Introduction outside its native range.
III. Spread to new habitats within the novel range.
IV. Ecological impact and disruption of local food webs.
(A) II → I → III → IV
(B) I → II → IV → III
(C) II → III → I → IV
(D) III → II → I → IV

2021

171. Clarias gariepinus (African catfish) is highly invasive in Indian water bodies. What biological trait makes it a potent threat to native fish diversity?
(A) It is an exclusively herbivorous and non-competitive species
(B) It requires highly specific and pristine habitats to spawn in nature
(C) Aggressive omnivore with accessory respiration allowing survival in mud
(D) It only preys on microscopic zooplankton in the water column

2010

172. The introduction of Oreochromis mossambicus (Mozambique tilapia) has caused significant ecological damage globally primarily through:
(A) Hybridization with various marine pelagic fishes in the ocean
(B) Discharging toxic chemicals and pollutants into the water column
(C) Restricting itself to deep, cold-water lakes and alpine systems
(D) Prolific breeding, parental care, and intense resource competition

2009

173. Pterois volitans (Red Lionfish) has caused catastrophic disruption to aquatic food webs in which invaded region?
(A) The Western Atlantic and Caribbean Sea
(B) The Mediterranean Sea
(C) The Indo-Pacific Ocean
(D) The Baltic Sea

2012

174. A major vector for the unintentional introduction of marine invasive alien species across global oceans is:
(A) Migratory bird pathways
(B) Discharge of ship ballast water
(C) Wind-blown oceanic sea spray
(D) Satellite tracking tags

2022

175. How does the invasive water hyacinth (Eichhornia crassipes) indirectly cause mortality in native fish populations?
(A) By secreting potent neurotoxins directly into the aquatic system
(B) Surface mats blocking sunlight and oxygen exchange, causing hypoxia
(C) By actively trapping and digesting juvenile fish for nutrients
(D) By hyper-oxygenating the water leading to gas bubble disease

2018

176. Which invasive fish, illegally introduced for aquaculture, poses a major threat to the native carps of India due to its voracious piscivorous feeding habit?
(A) Cyprinus carpio (Common carp)
(B) Pygocentrus nattereri (Red-bellied piranha) / Pacu variants
(C) Pangasianodon hypophthalmus (Sutchi catfish)
(D) Aristichthys nobilis (Bighead carp)

2023

177. "Biotic homogenization" in freshwater ecosystems, largely driven by IAS, refers to:
(A) The process where all fish eventually evolve into identical forms
(B) The equal distribution of nutrients across a large inland lake
(C) The standardization of water temperatures and currents globally
(D) Loss of unique endemics and replacement by adaptable non-natives

2018

178. Nile perch (Lates niloticus) introduction into Lake Victoria is a textbook example of:
(A) Successful enhancement of native biodiversity in the lake basin
(B) Restoration of a paleo-endemic habitat for future generations
(C) Biocontrol of various invasive aquatic weeds in the ecosystem
(D) Trophic cascade leading to extinction of endemic cichlid species

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2017

141. Bivalves (e.g., oysters and mussels) are frequently used as indicator species in coastal waters to monitor:
(A) Monitoring atmospheric ozone depletion in coastal regions
(B) Accumulation of pollutants via filter feeding
(C) Shifts in the pelagic migration routes of major fish stocks
(D) The genetic diversity and health of large marine mammals

2009

142. The "State Fish" concept in India aims to align regional pride with conservation. The Ganges River Dolphin, while a mammal, serves a similar symbolic role and is the official state aquatic animal of:
(A) Gujarat
(B) Assam
(C) West Bengal
(D) Kerala

2004

143. Which ecological role best describes a species that physically modifies, creates, or maintains aquatic habitats (e.g., beavers or reef-building corals)?
(A) Apex predator
(B) Ecosystem engineer
(C) Flagship species
(D) Indicator species

2025

144. Which surrogate species concept relies heavily on socio-economic and cultural appeal rather than strict ecological function?
(A) Keystone species
(B) Ecosystem engineer
(C) Flagship species
(D) Indicator species

2007

145. The "State Fish" initiative in India was largely promoted to:
(A) Align regional pride with conservation of native fish
(B) Commercialize a single species for heavy global export market
(C) Eradicate all non-state fish species from the local rivers
(D) Completely replace the National Fish board policies locally

2024

146. Which popular indigenous cyprinid is designated as the State Fish of multiple states, including Arunachal Pradesh, Himachal Pradesh, and Uttarakhand?
(A) Labeo rohita (Rohu)
(B) Wallago attu (Helicopter Catfish)
(C) Chitala chitala (Clown Knifefish)
(D) Tor putitora (Golden Mahseer)

2001

147. Kerala declared which endemic and economically valuable cichlid as its State Fish to promote its conservation and aquaculture?
(A) Etroplus suratensis (Pearl Spot / Karimeen)
(B) Oreochromis mossambicus (Mozambique Tilapia)
(C) Sahyadria denisonii (Miss Kerala)
(D) Horabagrus brachysoma (Yellow Catfish)

2017

148. The State Fish of West Bengal, known for its high culinary demand and estuarine biology, is:
(A) Pangasius pangasius
(B) Labeo bata
(C) Mystus tengara
(D) Tenualosa ilisha (Hilsa)

2005

149. Identify the CORRECT state fish declaration for the state of Bihar.
(A) Clarias magur (Magur)
(B) Channa marulius (Giant Snakehead)
(C) Notopterus notopterus (Bronze Featherback)
(D) Labeo calbasu (Black Rohu)

2024

150. Match the Indian States in List I with their respective declared State Fish in List II.
List I: (State)
P. Odisha
Q. Telangana
R. Manipur
S. Tripura
List II: (State Fish)
1. Murrel (Channa striata)
2. Mahanadi Mahseer (Tor mosal mahanadicus)
3. Pengba (Osteobrama belangeri)
4. Pabda (Ompok pabda)
(A) P-2, Q-1, R-3, S-4
(B) P-3, Q-4, R-1, S-2
(C) P-1, Q-2, R-4, S-3
(D) P-2, Q-3, R-4, S-1

to current records
(D) Impacted by water extraction, pollution, and fragmentation in watersheds

2004

189. In hotspot conservation, the "Gap Analysis" method is utilized to:
(A) Identify biodiversity unrepresented in existing protected areas
(B) Measure the physical distance between fragmented forest habitats
(C) Identify gaps in the genetic sequence of various endangered species
(D) Calculate the financial and budget deficit of conservation NGOs

2019

190. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): The biodiversity hotspot concept successfully prioritizes regions that maximize the protection of endemic species per conservation dollar spent.
Reason (R): Biodiversity hotspots cover only about 2.5% of the Earth's land surface, but host more than half of the world's plant species as endemics.
Which of the following is CORRECT?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2008

191. A core principle of systematic conservation planning is "Complementarity," which aims to:
(A) Select sites containing unrepresented species to maximize protection
(B) Ensure the new protected area is geographically adjacent to an old one
(C) Ensure terrestrial and marine reserves are perfectly symmetrical in shape
(D) Reintroduce extinct species to their former habitats for restoration

2003

192. Which criterion is fundamentally NOT a basis for Norman Myers' initial hotspot designation?
(A) High numbers of invasive species
(B) High floristic endemism
(C) Extreme threat of habitat destruction
(D) Exceptional concentration of species

2005

193. The IUCN Red List assessment framework assigns taxa to categories based on extinction risk. Which of the following is NOT an official IUCN category?
(A) Vulnerable (VU)
(B) Near Threatened (NT)
(C) Critically Endangered (CR)
(D) Partially Threatened (PT)

2013

194. A species is classified as "Extinct in the Wild" (EW) when:
(A) Its wild population drops below 100 individuals in the habitat
(B) It fails to breed in natural aquatic habitats during the season
(C) No individuals have been seen in their natural habitat for 5 years
(D) Known only to survive in cultivation, captivity, or as naturalized

2024

195. The IUCN Red List utilizes five quantitative criteria (A-E) for assessing threatened status. Criterion A specifically evaluates:
(A) Geographic range size measured by Extent of Occurrence or Area of Occupancy
(B) Small population size and consistent decline across all populations
(C) Reduction in population size over 10 years or 3 generations
(D) Quantitative analysis indicating probability of extinction through modeling

2021

196. Under IUCN Criterion B, "Area of Occupancy" (AOO) is distinguished from "Extent of Occurrence" (EOO) because AOO:
(A) Specific area within the EOO where the taxon physically occurs
(B) Only measures the area strictly inside designated Marine Protected Areas
(C) Measures the smallest convex polygon encompassing all known_survey sites
(D) Is exclusively used for terrestrial organisms and not aquatic ones

2023

197. To be listed as Critically Endangered (CR) under Criterion A (population reduction), what minimum percentage decline must be observed, estimated, inferred, or suspected over 10 years or 3 generations where causes are known and reversible?
(A) 50%

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irreversibly alters ecosystem state
(D) The highest point of a tidal wave during a storm surge event

2015
123. The classic example of an ecological regime shift in coral reefs involves the transition from a coral-dominated state to a state dominated by:
(A) Mangroves
(B) Fleshy macroalgae
(C) Sponges
(D) Pelagic phytoplankton

2018
124. Climate change impacts aquatic resilience primarily through "ocean acidification," which is caused by:
(A) Increased acid rain from industrial sulfur dioxide emissions
(B) The release of methane from melting permafrost in the Arctic
(C) Seawater absorbing anthropogenic carbon dioxide, lowering its pH
(D) The massive runoff of agricultural fertilizers into the sea

2004
125. How does ocean acidification specifically threaten calcifying marine organisms like pteropods and corals?
(A) It dissolves their soft tissues and internal organ systems
(B) Reduces availability of carbonate ions needed for skeleton formation
(C) It increases water temperature beyond their known thermal limits
(D) It triggers spontaneous and unsuccessful spawning in the wild

2022
126. A freshwater lake experiencing heavy agricultural runoff abruptly shifts from a clear-water, macrophyte-dominated state to a turbid, phytoplankton-dominated state. This illustrates:
(A) Ecological succession
(B) Alternative stable states and a regime shift
(C) Competitive exclusion
(D) Paleo-endemism

2009
127. Which factor is recognized as a major driver of reduced ecological resilience in commercially exploited fish populations?
(A) Age-truncation of large, old, and highly fecund individuals
(B) Successful introduction of Marine Protected Areas in the region
(C) Maintaining high genetic diversity within the target fish stock
(D) Maintaining consistently low fishing mortality rates in the area

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2018
128. Sea level rise impacts estuarine ecosystems by:
(A) Significantly decreasing overall estuarine salinity levels
(B) Saltwater intrusion shifting freshwater and halophytic communities
(C) Significantly lowering the regional freshwater water table
(D) Promoting the growth of strictly freshwater aquatic macrophytes

2008
129. Hysteresis in aquatic ecosystems implies that:
(A) Ecosystem returns to its original state through the same pathway
(B) Recovery threshold harder to reach than the degradation threshold
(C) Resilience is infinite regardless of the magnitude of stressors
(D) Tipping points only occur in marine and not freshwater systems

2012
130. Consider the following statements on climate change impacts:
I. Warmer waters hold less dissolved oxygen, leading to deoxygenation.
II. Marine heatwaves trigger widespread coral bleaching.
III. Climate velocity forces fish populations to shift their distributions toward the poles.
IV. Stratification of water bodies restricts vertical nutrient mixing.
V. Increased CO_2 enhances the calcification rate of marine bivalves.
Which of the above statement(s) is/are CORRECT?
(A) I, II and IV
(B) II, III and V
(C) I, III, IV and V
(D) I, II, III and V

2009
131. Coral bleaching is a direct breakdown of the symbiotic relationship between corals and:
(A) Zooxanthellae (dinoflagellates)
(B) Cyanobacteria
(C) Cleaning wrasses
(D) Boring sponges

(D) Genetic Modification Protocol

2019

207. CAMP workshops are typically coordinated globally by which organization/network?
(A) Food and Agriculture Organization (FAO)
(B) World Trade Organization (WTO)
(C) Greenpeace
(D) Conservation Breeding Specialist Group (CBSG) of the IUCN SSC

2019

208. During a regional CAMP for freshwater fishes of India, the assessment highlighted that the major threat to indigenous species was:
(A) Habitat degradation, flow alteration, and invasive species
(B) Overpredation by various aquatic birds and mammals in the area
(C) Natural and long-term paleoclimatic shifts in the region
(D) Extreme solar radiation impacting the surface water layers

2006

209. In the context of a CAMP workshop, how is traditional ecological knowledge (TEK) from local fisher communities typically treated?
(A) It is strictly excluded as it is not peer-reviewed in journals
(B) Integrated with scientific data to estimate population trends
(C) It is only used for commercially unimportant and non-target species
(D) It is utilized solely for the purpose of securing commercial patents

2012

210. Consider the following statements about CAMP workshops:
I. They involve purely ex situ conservation protocols.
II. They follow a rapid, participatory, and scientifically rigorous process.
III. They produce recommendations for research, conservation, and management.
Which of the above statement(s) is/are CORRECT?
(A) I and II
(B) II and III
(C) I and III
(D) I only

2010

211. Which specific outcome of a CAMP workshop directly bridges species assessment with actionable conservation?
(A) Formulating species-specific Conservation Action Plans (CAPs)
(B) Declaring all international waters as strictly no-take zones
(C) Enforcing immediate military protection of a major river basin
(D) Patenting indigenous and local genetic resources for commerce

2012

212. If a CAMP workshop concludes that a specific Mahseer species has an Extent of Occurrence of 3,000 km^2, is highly fragmented, and experiencing continuous decline in habitat quality, it will likely be categorized as:
(A) Least Concern
(B) Near Threatened
(C) Critically Endangered
(D) Endangered

2016

213. The "Management Plan" aspect of CAMP for an endangered aquatic species would least likely recommend:
(A) Establishment of several riverine and community-run sanctuaries
(B) Captive breeding and strategic ranching programs for restoration
(C) Strict regulation of all destructive fishing gear in the area
(D) Unregulated introduction of the species into foreign watersheds

2014

214. Which factor introduces the most uncertainty during aquatic CAMP workshops compared to terrestrial mammal assessments?
(A) Cryptic habitats and difficulty in obtaining abundance data
(B) Fish are entirely immune to environmental changes in the wild
(C) Fish have absolutely no economic or cultural value to locals
(D) Fish taxonomy and scientific names change on a daily basis

2022

215. A major success of regional CAMP workshops in India has been identifying species suitable for:
(A) Prioritized inclusion in Indian Wildlife (Protection) Act Schedules
(B) Granting massive national export subsidies

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to fisheries
(C) National eradication programs for all native species
(D) Genetic cross-breeding with invasive species for aquaculture

2011
216. The collaborative nature of CAMP workshops primarily helps overcome which common barrier in conservation biology?
(A) The physical barrier of large hydroelectric dams on rivers
(B) The chemical barrier of estuarine haloclines in the ocean
(C) The extremely high cost of obtaining satellite imagery data
(D) The 'Silo effect' where stakeholders do not share critical data

2016
217. In situ conservation is defined as the conservation of ecosystems and natural habitats and the maintenance of viable populations of species in their:
(A) Natural surroundings
(B) Zoological parks
(C) Cryogenic gene banks
(D) Laboratory aquaria

2001
218. A "No-Take Zone" (NTZ) within a Marine Protected Area (MPA) operates under the principle that:
(A) Only traditional hook-and-line fishing is permitted for locals
(B) Only catch-and-release fishing is allowed for recreational users
(C) Resource extraction is limited to specific and short seasons
(D) All forms of extractive activities are strictly prohibited

2016
219. One of the primary ecological benefits of a well-enforced no-take Marine Protected Area is the "Spillover Effect," which refers to:
(A) Outward migration of fish into adjacent unprotected grounds
(B) The leakage of pollutants from inside the MPA to outside areas
(C) The overflowing of tides due to protected coral reef structures
(D) The physical expansion of the MPA boundaries over several years

2003
220. Consider the following statements about Biosphere Reserves:
I. They consist of a strictly protected core zone.
II. They exclude human communities completely from all zones.
III. The buffer zone allows for sustainable resource use and research.
IV. They are an international designation under UNESCO's MAB program.
Which of the above statement(s) is/are CORRECT?
(A) I, III and IV
(B) I, II and III
(C) II, III and IV
(D) I and IV

2006
221. Riverine fish sanctuaries in India, such as those found on the Ganges and its tributaries, are often located near religious sites (e.g., temple sanctuaries) primarily because:
(A) Cultural and religious taboos naturally enforce non-fishing norms
(B) The water chemistry in these areas is naturally superior for fish
(C) They are the only places with deep water during the dry season
(D) Hydroelectric dams provide structured and safe fish habitats

2015
222. The Gulf of Mannar Biosphere Reserve is particularly critical for the in situ conservation of which vulnerable marine mammal?
(A) Ganges River Dolphin
(B) Blue Whale
(C) Sea Otter
(D) Dugong (Sea Cow)

2025
223. What represents the most significant challenge in establishing effective freshwater riverine protected areas compared to marine ones?
(A) Connectivity makes MPAs vulnerable to upstream pollution and dams
(B) Freshwater fish do not migrate from their home ranges at all
(C) Terrestrial mammals frequently consume all the fish in the area
(D) Freshwater ecosystems lack recognizable and distinct biodiversity

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2009

224. Which Indian National Park is a prominent in situ conservation site for the critically endangered Gharial and various freshwater turtle species?
(A) National Chambal Sanctuary
(B) Keoladeo National Park
(C) Jim Corbett National Park
(D) Sundarbans National Park

2009

225. Marine Protected Areas (MPAs) designated primarily to protect specific critical life-history stages, such as spawning aggregations or nursery grounds, rely on the protection of:
(A) Essential Fish Habitat (EFH)
(B) Deep-sea abyssal plains
(C) Terrestrial buffer zones
(D) Estuarine hypoxia zones

2010

226. In the zoning of a Biosphere Reserve, the outermost area where local communities, conservation agencies, and scientists collaborate on sustainable development is known as the:
(A) Transition Zone
(B) Core Zone
(C) Buffer Zone
(D) Exclusion Zone

2008

227. The effectiveness of an MPA in conserving biodiversity is highly dependent on achieving the "NEOLI" features, which stand for:
(A) No-take, Enforced, Old, Large, Isolated
(B) Native, Endemic, Oceanic, Large, Isolated
(C) Nutrient-rich, Estuarine, Open, Linear, Interconnected
(D) National, Ecological, Organized, Local, Identified

2019

228. Which in situ strategy dynamically protects highly mobile pelagic species (e.g., sea turtles, tuna) by utilizing real-time oceanic data to shift protected boundaries?
(A) Static Marine Reserves
(B) Dynamic Ocean Management
(C) Artificial Reef Deployment
(D) Mangrove Afforestation

2025

229. Ex situ conservation strategies are best defined as:
(A) Conservation of components of biological diversity outside their natural habitats
(B) In-river breeding programs
(C) Protection of habitats using satellite monitoring
(D) Eradication of invasive species in the wild

2019

230. Consider the following components regarding live gene banks:
I. They maintain live populations of endangered aquatic species in captivity.
II. They aim to maximize genetic diversity for future reintroductions.
III. They completely eliminate the risk of disease outbreaks.
IV. They often face challenges with inbreeding and genetic drift.
V. They are cheaper to maintain than cryogenic gene banks.
Which of the above statement(s) is/are CORRECT?
(A) I, II and IV
(B) II, III and V
(C) I, III, IV and V
(D) I, II and V

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2012

231. The primary purpose of captive breeding of endangered aquatic species, such as the Golden Mahseer, is:
(A) To supply the ornamental aquarium trades exclusively and globally
(B) Produce stock for restorative ranching to supplement populations
(C) To create completely new and faster-growing hybrid fish species
(D) To evaluate the toxicity of new industrial and agricultural chemicals

2007

232. A critical genetic concern during captive breeding programs of endangered fishes is the loss of wild adaptive traits due to:
(A) Domestication selection and founder effects
(B) Introgression
(C) Polyploidy induction
(D) Epigenetic hypermethylation

2016

233. Public aquaria play a vital role in ex situ conservation primarily through:
(A) Commercial and heavy harvesting of wild species for global trade
(B) Producing cheap and accessible protein for local urban communities
(C) Bioprospecting for new and profitable pharmaceutical patents in tanks

2011

289. The concept of Potential Fishing Zones (PFZ) generated in India by INCOIS integrates remote sensing data primarily to:
(A) Restrict fishing activity completely in various specific marine zones
(B) Guide fishermen to areas where fish are likely to aggregate
(C) Map the exact and precise locations of deep-sea coral reef systems
(D) Predict underwater tectonic activity and the occurrence of tsunamis

2015

290. The PFZ advisories are scientifically generated by superimposing (overlaying) which two primary satellite-derived parameters?
(A) Sea Surface Temperature (SST) and Sea Surface Salinity (SSS)
(B) Sea Surface Temperature (SST) and Chlorophyll-a concentration
(C) Ocean Depth and Tidal Amplitude
(D) Wave Height and Wind Speed

2014

291. Why do areas where specific SST gradients (thermal fronts) coincide with high Chlorophyll-a concentrations serve as excellent Potential Fishing Zones?
(A) Indicate upwelling and productivity, which attracts shoaling fish
(B) Because fish prefer highly turbid and hot water to avoid all predators
(C) Because these are areas with the lowest dissolved oxygen, causing fish to float
(D) Because dense phytoplankton blooms physically trap fish in these zones

2023

292. "Upwelling" zones, frequently mapped using RS and GIS for fishery applications, are characterized by:
(A) Cold, nutrient-rich deep waters rising, fueling phytoplankton blooms
(B) Warm, nutrient-depleted surface waters sinking to the deep ocean floor
(C) Rapid and permanent freezing of the surface aquatic layer in winter
(D) Complete and total absence of chlorophyll-a in the surface waters

2016

293. Which spatial operation is fundamentally performed in GIS to combine the SST raster layer and the Chlorophyll-a raster layer to demarcate PFZ boundaries?
(A) Complex Network Analysis
(B) Point density and concentration calculation
(C) Vector line smoothing and enhancement
(D) Boolean logic / Multi-criteria overlay analysis

2023

294. While PFZ advisories effectively reduce search time and fuel consumption for fishers, a major conservation concern regarding their unregulated use is:
(A) May lead to overexploitation if used by massive industrial fleets
(B) They cause various satellite sensors to degrade rapidly in space
(C) They accurately map the location of critically endangered benthic species
(D) They permanently alter the natural temperature of the surface ocean

2012

295. Which Indian satellite series is currently a vital operational asset for gathering real-time ocean color data used in generating PFZ advisories?
(A) Oceansat (e.g., OCM payload)
(B) Cartosat
(C) GSAT
(D) Chandrayaan

2012

296. Besides finding fish, the integration of RS and GIS using SST and chlorophyll data is crucially utilized in coastal management to monitor:
(A) The exact and precise genetic lineage of various invasive algae
(B) The extent, movement, and duration of Harmful Algal Blooms
(C) The daily and seasonal migration of individual marine sea turtles
(D) The structural and engineering integrity of concrete sea walls

2010

297. In spatial ecology, what is "ground resolution cell" essentially referring to when evaluating a Chlorophyll-a satellite map?
(A) Geometric size of a pixel representing a square area of ocean
(B) The physical laboratory where water samples are analyzed for data
(C) The biological cell size of the dominant and local phytoplankton
(D) The precise and daily frequency of the various satellite overpasses

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(C) They are too small and delicate for researchers to manipulate
(D) They naturally possess high levels of antifreeze proteins in cells

2005
243. Because fish embryos cannot currently be successfully cryopreserved, researchers focus heavily on the cryopreservation of:
(A) Fish milt and primordial germ cells (PGCs)
(B) Fish scales
(C) Whole adult fish
(D) Swim bladder tissue

2006
244. What is the essential role of cryoprotectants (e.g., DMSO, glycerol) in the cryopreservation process?
(A) To induce immediate and fireball cell division in frozen tissues
(B) Lower freezing point and reduce intracellular ice crystal formation
(C) To actively and quickly warm the cells during the thawing process
(D) To permanently and irreversibly alter the donor's DNA sequence

2018
245. The process of recovering live, fertile fish from cryopreserved primordial germ cells (PGCs) typically requires:
(A) Direct fertilization of a normal and fresh egg with a single donor PGC
(B) Growing the PGCs directly into fertile adult fish in a sterile petri dish
(C) Fusing two PGCs together using chemical and electrical stimuli
(D) Transplanting PGCs into a surrogate host which then produces donor gametes

2009
246. Tissue culture (e.g., fin explants) is utilized in advanced aquatic conservation primarily to establish:
(A) Cell lines for virological studies and future cloning
(B) Massive quantities of synthetic fish meat for global human consumption
(C) Biological filters for improving aquarium and tank water quality
(D) Artificial gills for assisting human diver respiration underwater

2018
247. During the thawing of cryopreserved fish milt, a critical step is typically the addition of an "activating solution" because:
(A) Initiate sperm motility via changes in osmolality or specific ions
(B) The sperm must be chemically stripped of its cryoprotectant immediately
(C) It stains the live sperm bright blue for accurate counting
(D) It physically and rapidly breaks the remaining ice crystals

NODIA

2005
248. Vitrification is an advanced cryopreservation technique that aims to:
(A) Convert solutions into glass-like solid without forming ice crystals
(B) Freeze cells extremely slowly over a period of several weeks
(C) Dehydrate the cells completely at room temperature before storage
(D) Replace the natural cell nucleus with a synthetic and modified one

2002
249. Which species was successfully propagated using surrogate broodstock technology, where its spermatogonia were transplanted into a closely related sterile salmonid host?
(A) Zebra Danio
(B) Bluefin Tuna
(C) Rainbow Trout / Masu Salmon
(D) Nile Tilapia

2003
250. Match the cryopreservation components in List I with their specific functions in List II.
List I: (Component)
P. Extender solution
Q. Dimethyl sulfoxide (DMSO)
R. Liquid nitrogen
S. Computer-controlled programmable freezer
List II: (Function)
1. Intracellular cryoprotectant preventing ice damage
2. Provides exact ultra-low storage temperature (-196°C)
3. Maintains osmotic balance and prevents premature sperm activation
4. Ensures an optimized and precise cooling rate
(A) P-3, Q-1, R-2, S-4
(B) P-1, Q-3, R-4, S-2
(C) P-3, Q-2, R-1, S-4

(D) P-2, Q-4, R-1, S-3

2022
251. Which statement represents a significant advantage of maintaining a cryogenic gene bank over a live gene bank?
(A) Arrests biological time, storing diversity with minimal space and cost
(B) Cryogenically frozen cells can evolve and adapt to climate change
(C) Cryogenic banks require massive amounts of feed and water filtration
(D) Cryopreserved specimens can be immediately released into the wild

2009
252. Somatic Cell Nuclear Transfer (SCNT) in aquatic species, while still experimental, represents a theoretical avenue for:
(A) Producing triploid sterile fish for various aquaculture applications
(B) Generating brilliant and bioluminescent transgenic fish for trade
(C) Resurrecting extinct species from frozen diploid somatic cell lines
(D) Enhancing the nutritional profile and flavor of fish fillets

2017
253. Community-based conservation (CBC) relies on the fundamental premise that:
(A) Centralized government control is the only way to manage natural resources
(B) Local communities must be completely excluded from all conservation areas
(C) Involving local communities and ensuring they receive socio-economic benefits
(D) Traditional practices are inherently destructive and must be outlawed

2005
254. A "Co-management" model in fisheries is characterized by:
(A) Sharing power and decision-making between government and local users
(B) Exclusive management by several large and international NGOs
(C) Complete privatization of aquatic resources to a single corporation
(D) Unregulated and open-access fishing in all national waters

2021
255. Traditional Ecological Knowledge (TEK) is distinct from formal scientific knowledge primarily because it is:
(A) Derived from empirical observations and intimate interaction with environment
(B) Based strictly on rigorous and controlled laboratory experimentation
(C) Exclusively focused on the study of genetically modified organisms
(D) Typically recorded in peer-reviewed and quantitative scientific journals

2005
256. Which traditional practice exemplifies community-based aquatic conservation in the Western Ghats of India?
(A) Cyanide fishing in coral reefs
(B) The protection of sacred pools (Temple Sanctuaries) where fishing is strictly taboo
(C) Blast fishing using dynamite
(D) Deep-sea bottom trawling

2019
257. Integrating TEK with scientific management is particularly valuable in fisheries for determining:
(A) Baselines of abundance, spawning grounds, and migration cues
(B) The precise molecular weight of various industrial toxins
(C) The chemical synthesis of modern and effective aquaculture drugs
(D) The complex design of high-tech and expensive satellite sensors

2006
258. The concept of "Territorial Use Rights in Fisheries" (TURFs) promotes conservation by:
(A) Giving various external commercial fleets access to local waters
(B) Assigning exclusive access rights to local communities to incentivize management
(C) Banning all human activity within a massive 200-mile marine radius
(D) Encouraging transient and nomadic fishing behaviors across boundaries

2024
259. A primary challenge in implementing successful co-management models is:
(A) Lack of trust, unequal power, and conflicting objectives between parties
(B) Too much local and traditional knowledge for managers to handle
(C) Fish populations reproducing too quickly for accurate assessment
(D) The extreme and unsustainable low cost of project implementation

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2004

260. The Community Reserve category under the Indian Wildlife (Protection) Act provides a legal framework for protecting areas that are:
(A) Owned exclusively and managed strictly by the central government
(B) Community-owned areas where locals protect habitat while retaining ownership
(C) Located far beyond the national Exclusive Economic Zone limits
(D) Strictly urban and concrete environments without natural habitat

2013

261. Participatory Rural Appraisal (PRA) techniques are utilized in aquatic conservation projects primarily to:
(A) Enforce maritime and river boundaries with heavily armed naval vessels
(B) Facilitate local people in mapping resources and conservation planning
(C) Extract raw genetic material and data from indigenous communities
(D) Conduct high-level genomic sequencing and molecular data analysis

2006

262. In co-management regimes, "Adaptive Management" specifically refers to:
(A) Monitoring and iteratively adjusting strategies based on new data
(B) Rigidly adhering to a very old and outdated management plan
(C) Adapting native fish to live in highly and severely polluted water
(D) Forcing local communities to adapt to significantly lower incomes

2009

263. A notable global example of successful marine community-based conservation involving "Locally Managed Marine Areas" (LMMAs) is widely established in:
(A) The Pacific Islands (e.g., Fiji, Philippines)
(B) The North Sea
(C) The Arctic Ocean
(D) The Mediterranean Coast

2018

264. What role do "customary laws" play in traditional fisheries management?
(A) Unwritten rules dictating gear, closures, and access within the community
(B) They are formal and written legislations passed by the central parliament
(C) They are various international treaties signed at the United Nations
(D) They mandate the maximum and total extraction of resources for trade

2003

265. Remote Sensing (RS) in aquatic sciences primarily involves:
(A) Physically capturing fish using large and deep-water nets at sea
(B) Obtaining information from a distance, typically via satellites
(C) Conducting on-site and complex chemical titrations in the field
(D) Exploring deep underwater caves using specialized scuba gear

2017

266. Which region of the electromagnetic spectrum is most effectively utilized by optical sensors for measuring ocean color and chlorophyll-a concentrations?
(A) Microwave
(B) Visible light (specifically blue and green bands)
(C) Ultraviolet
(D) X-ray

2016

267. What is the fundamental difference between active and passive remote sensors?
(A) Active sensors only work during the day; passive sensors only work at night
(B) Active sensors use visible light; passive sensors use thermal infrared only
(C) Active sensors emit energy and measure return; passive detect natural energy
(D) Active sensors are mounted on satellites; passive sensors are on buoys

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2006

268. Which satellite sensor type is crucial for mapping the exact topography of the seafloor (bathymetry) in shallow coastal waters from the air?
(A) Bathymetric LiDAR (Light Detection and Ranging)
(B) Thermal Infrared radiometer
(C) Passive Microwave radiometer
(D) High-frequency acoustic sonar on a submarine

2012

269. The penetration depth of visible light in an aquatic ecosystem depends primarily on:
(A) The altitude and orbital path of the satellite in space

(B) Influenced by sediments, organic matter, and phytoplankton
(C) The magnetic and electrical field of the Earth's surface
(D) The total speed and volume of the local oceanic current

2012

270. Synthetic Aperture Radar (SAR) is an active remote sensing technology particularly useful in oceanography because it:
(A) Can directly measure the DNA of various marine organisms at sea
(B) Measures absolute ocean depth up to a limit of 10,000 meters
(C) Directly calculates the exact species richness of coral reef systems
(D) Penetrate clouds and operate without solar light to detect surface features

2002

271. When using remote sensing to evaluate Sea Surface Temperature (SST), which part of the electromagnetic spectrum is predominantly monitored?
(A) Thermal infrared
(B) Gamma rays
(C) Ultraviolet
(D) Blue visible light

2010

272. In satellite oceanography, "Ocean Color" measurements are essentially proxies for:
(A) Chlorophyll-a concentration, indicating phytoplankton biomass
(B) The absolute abundance of various zooplankton species
(C) The exact and precise salinity of the surface water
(D) The seasonal depth of the thermocline in the open ocean

2014

273. Which Earth observation satellite series is highly renowned for its continuous, long-term multispectral imagery of coastal and terrestrial habitats?
(A) Landsat
(B) Hubble Space Telescope
(C) Voyager
(D) GPS Block III

2007

274. Spatial resolution in remote sensing defines:
(A) The total number of spectral bands a satellite sensor can detect
(B) Size of the smallest discernible feature represented by a pixel
(C) The time it takes for a satellite to complete one full orbit
(D) The sensitivity of the sensor to slight changes in energy magnitude

2018

275. "Ground truthing" is a critical component of any remote sensing project involving aquatic habitats. It involves:
(A) Field measurements at satellite locations to validate remote data
(B) Launching a secondary satellite to confirm the results of the first
(C) Calibrating the satellite sensor on the ground before its launch
(D) Creating a 3D physical and small model of the seafloor from mud

2014

276. Why is mapping underwater benthic habitats (like seagrass beds) using satellite optical imagery limited mostly to shallow coastal zones?
(A) Satellites are not programmed to look at deep water for research
(B) Water absorbs and scatters radiation, attenuating light beyond a depth
(C) Seagrass only grows during the night in deep water basins
(D) Deep water completely and perfectly reflects all incident light

2019

277. Geographic Information Systems (GIS) are distinct from simple digital maps primarily because GIS:
(A) Integrates spatial data with attributes, allowing for complex analysis
(B) Can only be printed on high-quality and large paper sheets
(C) Uses only vector data structures for all mapping purposes
(D) Is completely and totally independent of geographic coordinates

2002

278. In GIS, which spatial data structure represents discrete geographic features like a specific fish spawning site, a river segment, or the boundary of an MPA using points, lines, and polygons?
(A) Raster data model
(B) Vector data model
(C) TIN (Triangulated Irregular Network)
(D) Relational database table

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2012

279. Continuous spatial phenomena, such as a map of Sea Surface Temperature or chlorophyll concentration across the Indian Ocean, are best represented in GIS using the:
(A) Raster data model (a grid of cells/pixels)
(B) Vector data model
(C) Point feature class
(D) Line feature class

2008

280. Spatial interpolation in GIS is a process used to:
(A) Convert high-resolution satellite imagery into a printable format
(B) Estimate values at unsampled locations based on scattered points
(C) Permanently delete all erroneous or outlier spatial data
(D) Change the map projection from a 3D surface to a 2D plane

2004

281. Inverse Distance Weighting (IDW) and Kriging are examples of:
(A) Remote sensing satellite platforms
(B) Vector-to-raster conversion algorithms
(C) Spatial interpolation techniques
(D) Ex situ conservation strategies

2002

282. When creating an aquatic habitat suitability model in GIS, the process of combining multiple raster layers (e.g., depth, temperature, substrate type) using a mathematical formula is known as:
(A) Geocoding
(B) Buffering
(C) Digitizing
(D) Map algebra / Raster overlay

2007

283. A GIS analyst wants to define a 5-kilometer no-fishing zone around a critically endangered coral reef polygon. Which geoprocessing tool should they use?
(A) Buffer
(B) Clip
(C) Intersect
(D) Erase

2005

284. In mapping spatial aquatic data, a "map projection" is required to:
(A) Transform Earth's 3D surface onto a 2D flat plane
(B) Significantly increase the color contrast and brightness of the map
(C) Efficiently translate attribute data into complex spatial geometry
(D) Capture real-time and high-resolution satellite imagery for study

2002

285. Which GIS application is most relevant for mitigating the threat of invasive alien species?
(A) Predicting range expansion and identifying vulnerable habitats
(B) Digitally increasing the population size of various native species
(C) Designing and testing better fishing nets for commercial fleets
(D) Calculating the exact genetic mutation rate of the alien invader

2014

286. What is a "Digital Elevation Model" (DEM), and what is its equivalent term for mapping the depth of water bodies?
(A) A 3D representation of terrain surface; Digital Bathymetric Model (DBM)
(B) A model of atmospheric pressure; Bathymetric Model
(C) A vector map of roads; Sonar Map
(D) A temperature grid; Thermal Map

2002

287. Which of the following defines the attribute data in a GIS database for an aquatic study?
(A) The exact and precise X, Y coordinates of a water sampling station
(B) The physical pixel size of the captured satellite imagery image
(C) The mathematical algorithm used to display the digital map
(D) Tabular info like pH, oxygen, and date associated with a station

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2018

288. Which statement correctly identifies an advantage of using vector data over raster data in GIS?
(A) Vector data is superior for representing continuous gradients like temperature
(B) Vector data typically requires more storage space for simple features
(C) Vector data accurately represents individual pixels more efficiently
(D) Represents precise geometric boundaries and network topology

(D) Public education and providing facilities for breeding and rescue

2025

234. Live gene banks for aquatic species must carefully manage the "Effective Population Size (Ne)" to minimize inbreeding. Which mating strategy is commonly employed to maintain Ne?
(A) Factorial mating designs and pedigree tracking
(B) Full-sibling mating
(C) Using a single highly fecund male to fertilize all females
(D) Allowing complete panmictic random mating without records

2010

235. What is a primary limitation of relying exclusively on live ex situ conservation for aquatic organisms?
(A) It requires very little infrastructure or specialized personnel
(B) Capital-intensive and vulnerable to failures like power loss or disease
(C) It preserves too much genetic diversity for future use in nature
(D) It makes the fish aggressive and unsuitable for release in the wild

2001

236. The concept of "Conservation Aquaculture" fundamentally differs from "Commercial Aquaculture" because its primary metric of success is:
(A) Genetic integrity, fitness, and survival of fish post-release
(B) Maximum biomass output and efficient feed conversion ratio
(C) Rapid growth rates and aesthetically pleasing coloration patterns
(D) Complete and total domestication of the captive broodstock

2014

237. Which endangered species was successfully bred in captivity in India and restocked into the wild to aid its recovery?
(A) Chitala chitala
(B) Atlantic Cod
(C) Coelacanth
(D) Nile Perch

2025

238. What is the fundamental role of "studbooks" in ex situ conservation breeding programs?
(A) Registry of pedigrees and demographic history to inform breeding
(B) To record the financial and maintenance expenses of the facility
(C) To document the daily feeding schedules of all captive animals
(D) To track the geographical migration of wild fish populations

2005

239. "Headstarting" is an ex situ conservation strategy specifically designed to:
(A) Protect juveniles in captivity until they are less susceptible to predation
(B) Induce rapid and premature sexual maturation using hormones
(C) Transport adult fish to new, unoccupied and foreign river basins
(D) Sterilize all invasive species before their release into the wild

2009

240. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): Ex situ conservation is intended to be a substitute for in situ conservation.
Reason (R): Captive environments can perfectly replicate all ecological interactions and evolutionary pressures found in nature.
Which of the following is CORRECT?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2013

241. Cryopreservation of fish gametes involves freezing and storing cells at ultra-low temperatures, typically using liquid nitrogen at:
(A) -269°C
(B) -196°C
(C) -78°C
(D) -20°C

2004

242. In fish cryopreservation, what is the critical biological barrier that currently prevents the widespread successful cryopreservation of fish eggs (ova) and embryos?
(A) Size, yolk volume, and chilling sensitivity inhibit cryoprotectant penetration
(B) They completely lack a protective and durable chorion layer

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2011

298. To accurately overlay SST and Chlorophyll-a images in a GIS environment, both spatial datasets must first undergo:

(A) Complete decolorization of the imagery

(B) Conversion of all imagery to vector point data

(C) Topographical flattening of the Earth's surface

(D) Georeferencing to ensure they align to the same coordinate system

2024

299. In determining marine pelagic habitats, what feature visible on SST imagery indicates a "mesoscale eddy" which often traps nutrients and attracts marine predators?

(A) A straight, linear thermal boundary stretching across an ocean basin

(B) A circular or spiral-shaped anomaly in surface temperature

(C) A completely uniform, homogenous temperature block

(D) A permanent localized hot spot over a volcanic vent

2008

300. Which statement best summarizes the ultimate utility of integrating RS and GIS in aquatic biodiversity conservation?

(A) It replaces the need for any traditional biological understanding of species

(B) It permits the total and safe automation of commercial fishing vessels

(C) Framework to monitor changes, map habitats, and design protected areas

(D) It restricts research exclusively to the thin surface layer of the ocean

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19. (A) Beta diversity
The Jaccard index is a classic similarity coefficient used to compare the species composition of different communities. By measuring the proportion of shared species relative to the total species pool, the index quantifies species turnover. Therefore, applying this metric between two estuaries directly investigates beta diversity, showing how communities change across spatial gradients.

20. (B) II and IV
High species turnover across habitats yields high beta diversity, making statements indicating otherwise incorrect. Furthermore, as habitat heterogeneity increases, beta diversity typically increases because different microhabitats support unique species assemblages. Understanding these spatial relationships is fundamental for designing effective conservation networks that capture diverse species communities across regional scales.

21. (B) It significantly decreases
Biological homogenization occurs when invasive species establish across multiple locations while native species decline. This process reduces the unique differences in species composition between distinct sites. As a result, the species turnover between habitats is minimized, causing a significant decrease in beta diversity and leading to ecologically uniform communities across the river system.

22. (B) Alpha, Beta, Gamma
This sequence correctly represents the hierarchical scaling of species diversity from the smallest to the largest geographical area. Alpha diversity represents localized species richness within a single habitat, beta diversity measures the species turnover between habitats, and gamma diversity represents the total species richness across the entire regional landscape or geographic area.

23. (D) Low nutrient availability restricting the quantity of viable niches
Oligotrophic lakes are characterized by low nutrient concentrations, which limits primary productivity. This nutrient scarcity restricts the availability of resources and diverse ecological niches, supporting only a few specialized phytoplankton species. Consequently, local alpha diversity remains low, as only species adapted to efficient nutrient uptake can survive and persist in these conditions.

24. (A) High regional habitat complexity and historical geological stability
The exceptional gamma diversity of the Indo-Pacific Coral Triangle is driven by high regional habitat complexity and long-term geological stability. These factors have allowed diverse marine species to evolve, persist, and accumulate over evolutionary timescales. The complex geography provides numerous refuges and niches, promoting high rates of speciation and low extinction rates.

25. (B) Standardize species richness comparisons across samples of varying sizes
Rarefaction is a statistical technique used to standardize species richness estimates when comparing samples with different numbers of individuals. By generating expected species richness curves based on a common sample size, researchers can make unbiased comparisons. This technique is essential in aquatic studies where sampling effort and gear efficiency vary across sites.

26. (B) Bottom trawl
A bottom trawl is the most effective gear for quantitatively sampling demersal fishes, which live on or near the seafloor. This active sampling gear sweeps a standardized area of the seabed, collecting representative samples of bottom-dwelling organisms. Other gears like purse seines, longlines, or plankton nets target pelagic species or specific size classes.

27. (A) Total richness based on the count of rare species like singletons
The Chao1 estimator is a non-parametric statistical method designed to estimate true species richness from sampling data. It estimates the number of undetected species based on the frequency of rare species, specifically singletons and doubletons, in the sample. This approach is highly useful in biodiversity surveys where many rare species remain undetected.

28. (C) It samples a standardized, fixed area of the benthic substrate
A Surber sampler is designed with a fixed metal frame that delineates a standardized area of the stream bed for quantitative benthic sampling. This design allows researchers to calculate precise

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international funding and efforts toward the most threatened regions. Other historical events, like the Stockholm Conference and IUCN Red List, have different origins and developmental timelines.

10. (C) I and III
Genetic diversity provides the variation necessary to prevent inbreeding depression in populations. Ecosystem diversity encompasses the intricate relationships between living organisms and their non-living physical environments. Species diversity is measured using both species richness and species evenness, making the assertion that it relies solely on richness incorrect in standard ecological assessment.

11. (A) High fixation index (FST)
A high fixation index indicates significant genetic differentiation and restricted gene flow, often reflecting low genetic diversity within sub-populations. In cultured fish populations, this metric correlates with increased homozygosity and reduced overall variation. Monitoring this genetic index is crucial for hatchery managers to avoid inbreeding depression and maintain the long-term evolutionary fitness of stocks.

12. (C) Genetic diversity
The existence of diverse color morphs within a single species, such as the guppy, directly reflects genetic diversity. These intraspecific variations arise from differences in alleles and genetic combinations among individuals. This genetic variation is crucial for survival, as it allows populations to adapt to varying predation pressures and sexual selection preferences in different habitats.

13. (D) Beta diversity
Beta diversity measures the rate of change in species composition, or species turnover, between different habitats or communities. By comparing species lists between distinct environments, such as a lake and its adjacent wetland, ecologists can quantify spatial variation. High beta diversity indicates that the compared habitats contain highly unique and distinct biological assemblages.

14. (C) Diversity of species within a single localized habitat or community
Alpha diversity represents the species diversity within a localized area, community, or ecosystem. It typically focuses on species richness and evenness within a single sampling site. In aquatic research, measuring alpha diversity helps scientists establish a baseline of local community structure and assess the immediate impacts of localized environmental changes or pollution events.

15. (B) Moderate alpha and high beta diversity
When multiple separate ponds have the same number of species but share no species in common, the local alpha diversity remains moderate. However, the complete lack of shared species between these distinct habitats results in high beta diversity. This spatial pattern indicates strong species turnover across the landscape, which ultimately contributes to high regional gamma diversity.

16. (D) Gamma = Alpha $\times$ Beta
Whittaker's multiplicative model defines gamma diversity as the product of alpha diversity and beta diversity. In this mathematical formulation, alpha represents local diversity, beta represents the differentiation between habitats, and gamma represents the total regional diversity. This model allows ecologists to partition regional diversity into its local and spatial turnover components for conservation planning.

17. (A) The habitats possess distinct and unique species assemblages
A high beta diversity value between an upstream riffle and a downstream pool indicates that the two habitats support distinct and unique species assemblages. This high rate of species turnover reflects differences in physical conditions, such as current velocity, substrate type, and oxygen levels, which favor different macroinvertebrate communities in each river reach.

18. (C) The total biodiversity of an entire coastal eco-region
Gamma diversity measures the total species richness across a broad regional landscape or seascape. In marine spatial planning, assessing gamma diversity allows managers to understand the cumulative biodiversity of an entire coastal eco-region. This broad perspective is essential for designing networks of marine protected areas that capture representative habitats and regional species pools.

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effective indicator of toxic pollution in river systems.

78. (B) Tolerance to organic pollution
The Biological Monitoring Working Party score system assigns numerical values to macroinvertebrate families based on their sensitivity to organic pollution. Highly sensitive taxa receive high scores, while pollution-tolerant families receive low scores. The sum of these scores reflects the overall health of the stream, with higher values indicating cleaner water.

79. (A) Organic loading from untreated sewage
Benthic community dominated by Tubificid worms with almost no sensitive EPT taxa indicates severe organic loading, typically from untreated sewage. These worms thrive in high-nutrient, hypoxic sediments where they feed on organic matter. This extreme shift in community structure is a classic biological signature of organic pollution in rivers.

80. (D) Chemical testing only provides a 'snapshot' of conditions
A major disadvantage of physical and chemical water testing is that it only provides a snapshot of environmental conditions at the exact moment of sampling. Transient pollution events or intermittent discharges can easily be missed. In contrast, biomonitoring integrates the ecological impacts of these disturbances over the lifespan of the resident aquatic organisms.

81. (A) Biomass (Ash-Free Dry Weight) to Chlorophyll-a
The Autotrophic Index evaluates the ratio of ash-free dry weight to chlorophyll-a concentration in periphyton samples. This ratio reflects the balance between autotrophic and heterotrophic organisms in the community. High values indicate a shift toward heterotrophy, which often occurs in response to organic pollution and elevated nutrient levels in the water.

82. (C) The index counts the number of taxa in three sensitive insect orders
The EPT index is calculated by counting the number of distinct taxa within the sensitive insect orders Ephemeroptera, Plecoptera, and Trichoptera. A higher index value indicates a healthier stream with clean water and diverse habitats. These taxa are typically found in flowing, well-oxygenated water rather than stagnant, highly turbid environments.

83. (A) Compare observed macroinvertebrate fauna with expected pristine fauna
The River Invertebrate Prediction and Classification System is a software tool used in biomonitoring. It predicts the macroinvertebrate community expected to occur at a site in the absence of environmental stress. By comparing this predicted pristine community with the observed fauna, scientists can quantify the degree of biological degradation.

84. (A) Diatoms (Bacillariophyta)
Diatoms are highly sensitive to changes in water chemistry, particularly pH. Their silica cell walls, called frustules, persist in lake sediments after they die. By analyzing fossil diatom assemblages in sediment cores, researchers can reconstruct historical changes in lake pH, providing critical insights into long-term acidification trends.

85. (A) Systematic search for biochemical and genetic information in nature
Bioprospecting in aquatic environments involves the systematic search for valuable biochemical compounds and genetic resources in marine or freshwater organisms. The goal is to discover novel molecules for pharmaceutical, industrial, or agricultural applications. This process must be conducted sustainably to avoid overexploiting natural populations or damaging sensitive aquatic habitats.

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86. (A) Produce novel secondary metabolites as defense mechanisms
Sessile marine organisms like sponges and tunicates cannot flee from predators or competitors. To survive, they have evolved complex chemical defenses, producing unique secondary metabolites. These bioactive compounds are highly attractive to bioprospectors because they often exhibit powerful antimicrobial, antiviral, or anticancer properties suitable for drug development.

87. (A) Cone snails (Conus spp.)
Ziconotide is a powerful non-opioid painkiller developed by bioprospecting the peptide venom of marine cone snails. These predatory snails use highly complex neurotoxins to paralyze their prey. Isolating and synthesizing these specific peptides has provided medicine with a potent

density and biomass metrics per unit area. In contrast, kick nets are primarily qualitative or semi-quantitative and do not restrict sampling to a precise spatial footprint.

29. (D) The sampling effort has captured the community's total species richness
When a species accumulation curve flattens to form an asymptote, it indicates that the addition of further sampling units is unlikely to yield new species. This pattern shows that the sampling effort has been sufficiently thorough to detect almost all species present in the community, providing a reliable estimate of total species richness.

30. (B) II, III and IV
Rarefaction curves interpolate data to smaller sample sizes, while extrapolation estimates richness beyond the sampled dataset. Additionally, environmental DNA metabarcoding successfully detects species presence without requiring physical capture. Other sampling methods, such as electrofishing and gillnets, are highly size-selective and species-selective, meaning they do not provide unbiased community samples.

31. (B) Detects species presence from water samples without physical capture
Environmental DNA metabarcoding allows researchers to detect the presence of diverse aquatic organisms by analyzing cellular debris shed into the water column. This non-invasive method identifies species from water samples without requiring physical capture or visual observation. It is highly sensitive, making it ideal for detecting rare, cryptic, or invasive species in aquatic habitats.

32. (D) It relies on presence/absence data across multiple sampling units
The incidence-based Coverage Estimator utilizes presence/absence data across multiple sample replicates rather than absolute individual counts. This makes it highly useful in aquatic surveys where counting every individual is impractical or where gear bias makes abundance estimates unreliable. It focuses on the frequency of rare species across samples to estimate true richness.

33. (A) Size-selective catchability
Gillnets are highly size-selective, as individual mesh sizes only capture fish within a narrow physical size range. By using a multi-mesh gillnet containing a series of different mesh sizes, researchers can sample a broader range of fish sizes. This approach minimizes size-selective catchability bias, providing a more representative picture of the fish community.

34. (C) Monte Carlo resampling without replacement
Generating a sample-based rarefaction curve involves repeatedly calculating species richness for different sub-samples of the data. This process relies on Monte Carlo resampling techniques without replacement to average the species occurrence patterns. This statistical approach smooths out the fluctuations caused by the order in which samples are added, yielding a standardized curve.

35. (A) The frequency of unique species that occur in only one or two samples
The Jackknife estimator is a non-parametric resampling technique used to estimate species richness. It calculates the total richness by analyzing the distribution of rare species, specifically those that appear in only one sample (uniques) or two samples (duplicates). This method reduces estimation bias and provides a reliable projection of species richness in heterogeneous environments.

36. (D) Difficulty in distinguishing between different fish species
Hydroacoustic surveys use sound waves to detect fish and map their distribution across large water bodies. While highly efficient for estimating biomass and abundance, this technology struggles to identify specific species because different fish can produce similar acoustic targets. Consequently, physical sampling is usually required alongside hydroacoustics to confirm taxonomic composition.

37. (B) Species richness and relative abundance (evenness)
The Shannon-Weiner index is a widely used metric that evaluates diversity by combining species richness with evenness. It measures the uncertainty in predicting the species identity of an individual chosen at random. By accounting for both the number of species and their relative abundances, it provides a comprehensive measure of community structure.

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58. (B) One is dominated by a few species while the other is evenly distributed
Two aquatic habitats can share the same species richness but function differently if their relative abundances differ. One community may be heavily dominated by a single species, while the other has individuals evenly distributed among all taxa. Assessing dominance and evenness alongside richness reveals these structural and functional differences.

59. (A) Inversely proportional
The relationship between species dominance and diversity is generally inversely proportional. As a single species increases in relative abundance and dominates the community, the overall evenness and diversity of the ecosystem decrease. Conversely, when dominance is low, individuals are shared more evenly among species, resulting in higher diversity indices.

60. (A) II → III → I → IV
Calculating Pielou's Evenness Index requires a structured sequence of mathematical steps. First, the total number of species must be counted. Second, the Shannon-Weiner Index is calculated. Third, the maximum possible diversity is determined using the natural logarithm of richness. Finally, the observed Shannon index is divided by this maximum value.

61. (A) Species formerly widespread but now restricted to a localized area
Paleo-endemism refers to species that were once widely distributed but are now restricted to small, localized geographic refuges. This restriction often results from historical climate shifts, continental drift, or habitat fragmentation over evolutionary timescales. These species represent ancient lineages that have survived in isolated pockets while their relatives went extinct elsewhere.

62. (D) Kryptoglanis
The catfish genus Kryptoglanis is a remarkable example of paleo-endemism found in the subterranean waters of the Western Ghats. This unique fish possesses unusual skeletal features that set it apart from other modern catfishes. Its restricted subterranean distribution represents an ancient lineage that has survived in isolation within these underground aquifers.

63. (B) Rapid recent speciation due to isolation and divergent adaptation
Neo-endemism is driven by rapid, geologically recent speciation events. This process occurs when populations become isolated in unique habitats, leading to divergent adaptation and reproductive isolation. These newly emerged species are restricted to their area of origin because they have not had sufficient time to disperse into other geographic regions.

64. (D) North-East India (Meghalaya)
The blind swamp eel is a highly specialized, cave-dwelling endemic species native to the subterranean waters of Meghalaya in North-East India. This species has adapted to life in total darkness, exhibiting a lack of pigmentation and reduced visual structures. Its restricted distribution within cave systems highlights the unique subterranean biodiversity of this region.

65. (A) Cyprinidae (e.g., Denison barb)
The family Cyprinidae exhibits a high degree of endemism in the fast-flowing stream systems of the Western Ghats. Iconic species like the Denison barb are adapted to these cool, highly oxygenated habitats. The complex topography and isolation of these river basins have promoted the speciation and persistence of numerous endemic cyprinids.

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66. (D) Tor putitora - Coromandel Coast estuaries
The Golden Mahseer is a cold-water riverine fish native to the fast-flowing streams of the Himalayan foothills, making its pairing with the brackish estuaries of the Coromandel Coast incorrect. The other options represent accurate pairings of endemic Indian freshwater fishes with their primary native regions, such as the Western Ghats and Kerala backwaters.

67. (A) Cichlids in the African Rift Lakes
The adaptive radiation of cichlid fishes in the African Rift Lakes is a classic example of neo-endemism. From a few ancestral species, hundreds of unique species evolved rapidly to exploit diverse ecological niches within these isolated lakes. This rapid speciation highlights how habitat isolation can drive evolutionary diversification.

rare species, which are often missed in smaller samples.

48. (D) 0.0
In an aquaculture pond containing only a single species, such as Carp, there is no species diversity. Mathematically, the proportion of this single species is one, and the natural logarithm of one is zero. Consequently, the Shannon-Weiner diversity index value for this monotypic system is zero, representing the minimum possible diversity.

49. (A) Shannon-Weiner index
Pielou's Evenness Index is mathematically derived from the Shannon-Weiner index. It is calculated by dividing the observed Shannon diversity value by the maximum possible diversity for that species richness. This conversion yields a standardized value between zero and one, allowing direct comparisons of evenness across different ecological communities.

50. (A) P-3, Q-2, R-1, S-4
These matchings correctly align each diversity index with its mathematical description. The Shannon index relates to information entropy, the Simpson index evaluates the probability of intraspecific encounters, Pielou's index measures the ratio of observed to maximum possible diversity, and Margalef's index scales species richness using the natural logarithm of total individuals.

51. (A) The maximum possible Shannon diversity
In the formula for Pielou's evenness, the natural logarithm of species richness represents the maximum possible Shannon diversity value. This maximum occurs when all species in the community are present in equal abundances. Dividing the observed Shannon index by this theoretical maximum normalizes the value, providing a measure of evenness.

52. (D) The individuals are distributed highly evenly among the species
A Pielou's Evenness value of point nine five is extremely close to the theoretical maximum of one. This high value indicates that individuals within the benthic community are distributed highly evenly among the present species. There is no strong dominance by any single species, suggesting a stable and balanced community structure.

53. (B) The relative abundance of the single most abundant species
The Berger-Parker Dominance Index is a simple mathematical measure of diversity. It is calculated by dividing the abundance of the single most abundant species by the total number of individuals in the sample. This index reflects the level of dominance within the community using only the most common taxon.

54. (C) Environmental stress or enrichment favoring opportunistic taxa
High species dominance in an aquatic ecosystem often indicates environmental stress or organic enrichment. These conditions eliminate sensitive species while allowing highly tolerant, opportunistic taxa to thrive and dominate the community. Consequently, resources are monopolized by a few species, resulting in reduced evenness and lower overall biological diversity in the system.

55. (C) 1.0
If every species in a community is represented by the exact same number of individuals, the community exhibits perfect evenness. Mathematically, the observed Shannon-Weiner index will equal the maximum possible diversity. Dividing these identical values results in a Pielou's Evenness Index value of exactly one point zero, representing maximum evenness.

56. (A) Algal bloom of a toxic cyanobacteria species
An algal bloom of a toxic cyanobacteria species leads to a massive proliferation of a single taxon. This rapid growth shifts the community balance, causing this species to dominate the ecosystem while other phytoplankton decline. This extreme shift in relative abundance reduces species evenness and lowers the overall diversity index of the lake.

57. (B) Less sensitive to species richness and independent of rare species
Simpson's measure of evenness is mathematically less sensitive to variations in species richness compared to Pielou's index. Because it is derived from the Simpson index, it focuses on dominant species and is largely independent of rare species. This property makes it a robust measure of evenness in large, diverse datasets.

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38. (C) The proportion of individuals belonging to the ith species
In the Shannon-Weiner mathematical formula, the variable represents the proportion of individuals belonging to each specific species relative to the total number of individuals in the sample. This proportion is crucial because it weights the contribution of each species, ensuring that relative abundance is incorporated alongside species richness in the final index value.

39. (D) The most dominant species in the community
Simpson's Diversity Index measures the probability that two individuals randomly selected from a sample belong to the same species. Because it squares the relative abundances of each species, the index is heavily weighted toward the most abundant, dominant species. It is less sensitive to rare species compared to other informational indices like the Shannon index.

40. (A) Both A and R are true and R is the correct explanation of A.
The Shannon-Weiner index is highly sensitive to the presence of rare species in a sample. This sensitivity is due to the logarithmic component of the mathematical formula, which disproportionately amplifies the weights of species with low relative abundances. Thus, both statements are factually correct, and the reason perfectly explains the observed mathematical behavior.

41. (B) The effect of varying sample sizes
Margalef's richness index calculates species richness by incorporating the total number of individuals sampled. It attempts to control for the sampling bias where larger sample sizes naturally yield more species. By dividing the number of species by the natural logarithm of the sample size, it standardizes richness comparisons across different collection efforts.

42. (B) High diversity with individuals well distributed among species
A Simpson's Index value of point eight, when calculated using the complementary form of one minus D, indicates high diversity. This high value shows that individuals are evenly distributed among the various species present in the habitat, with a very low probability that two randomly selected individuals will belong to the same species.

43. (A) Simpson's dominance index
Simpson's dominance index measures the probability that two individuals selected at random from a community belong to the same species. It is calculated by summing the squared proportions of each species. High values of this index indicate low overall diversity and strong dominance by a few highly abundant species within the ecological community.

44. (C) $H\hat{a}\text{€}^{TM}$ will decrease, while D (dominance) will increase
Severe environmental pollution typically eliminates sensitive species, allowing a few tolerant, opportunistic species to proliferate. This ecological shift reduces the overall species evenness and richness, causing the Shannon-Weiner index to decrease. Conversely, the high abundance of a few tolerant taxa increases Simpson's dominance index, reflecting a highly stressed and simplified community.

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45. (D) It behaves linearly, allowing intuitive comparisons of diversity
Converting traditional diversity indices to Hill numbers, or the effective number of species, simplifies ecological interpretation. Unlike raw entropy values, Hill numbers behave linearly and correspond directly to species counts. This linear property allows researchers to make intuitive and mathematically consistent comparisons of diversity across different communities, seasons, or environmental gradients.

46. (C) It assumes a linear relationship between species number and the logarithm of population size
Margalef's index is primarily a measure of species richness and does not account for species evenness, making the assertion that it represents evenness incorrect. The index assumes a linear relationship between the number of species and the logarithm of sample size. It is used to standardize species counts without assessing relative abundance distributions.

47. (B) Its focus on the variance of relative abundance distribution
The mathematical robustness of the Simpson index against variations in sample size stems from its focus on the relative abundance distribution. Because it emphasizes dominant species and squares their proportions, the index is less influenced by the presence or absence of

68. (A) High hydrological connectivity to major global oceans
High hydrological connectivity to global oceans facilitates gene flow and dispersal, which prevents geographic isolation and reduces the likelihood of local speciation. Conversely, geographical barriers, stable microclimates, and unique geological substrates restrict gene flow. These isolating factors are essential for promoting the evolution of both paleo-endemic and neo-endemic species.

69. (B) River damming and hydroelectric projects altering flow regimes
The Golden Mahseer is a migratory riverine fish that requires connected, fast-flowing streams for spawning. The construction of dams and hydroelectric projects in the Himalayas blocks these migration pathways and alters natural flow regimes. This habitat fragmentation represents the most significant threat to the survival of this endemic cold-water species.

70. (A) II → IV → I → III
The formation of paleo-endemic species follows a specific historical sequence. Initially, a widespread species occupies a vast, continuous aquatic network. Next, geological or climatic changes fragment this habitat. The species then goes extinct across the broader surrounding areas. Finally, it survives only as a relict population within a restricted, isolated refuge.

71. (A) Brahmaputra basin
The Brahmaputra River basin is the primary drainage network supporting the high diversity of endemic freshwater fishes in North-East India. The region's complex topography, heavy rainfall, and varied aquatic habitats have promoted the evolution of unique fish species. This basin serves as a critical evolutionary corridor and a global hotspot for freshwater biodiversity.

72. (A) Autochthonous endemics
Autochthonous endemics are species that evolved in the same restricted geographic location where they are found today. Their origin and current distribution are identical, reflecting localized speciation and adaptation. In contrast, allochthonous endemics evolved elsewhere and subsequently became restricted to their current refuge due to extinction in other parts of their historical range.

73. (D) Are relatively sedentary and reflect long-term site-specific water quality
Benthic macroinvertebrates are highly effective indicators for biological monitoring because they are relatively sedentary and cannot easily escape localized pollution. Their community composition integrates the cumulative impacts of environmental stressors over time. This makes them superior to chemical tests, which only capture a snapshot of water quality at the moment of sampling.

74. (A) Ephemeroptera, Plecoptera, Trichoptera
In aquatic biomonitoring, the EPT index stands for three sensitive insect orders: Ephemeroptera, Plecoptera, and Trichoptera. These organisms are highly sensitive to organic pollution, sedimentation, and oxygen depletion. Consequently, calculating their relative abundance within a stream sample provides a reliable measure of water quality and overall habitat health.

75. (A) High water quality with high dissolved oxygen
A high abundance of Ephemeroptera, Plecoptera, and Trichoptera taxa indicates clean, well-oxygenated water. These insect larvae have low tolerance for organic pollution and hypoxia. Their presence in diverse assemblages signals that the stream ecosystem is healthy, with low levels of siltation, minimal organic loading, and stable ecological conditions.

76. (A) Chironomidae (Non-biting midges)
Chironomidae larvae are highly tolerant of organic pollution and low dissolved oxygen levels. Many species within this family possess hemoglobin, which allows them to survive in hypoxic sediments. Consequently, a high abundance of these midges alongside a lack of sensitive taxa indicates degraded water quality and significant environmental stress.

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77. (A) Nutrient enrichment and heavy metal bioaccumulation
Periphyton consists of complex mixtures of algae, cyanobacteria, and microbes attached to submerged surfaces. Because they are primary producers, they respond rapidly to nutrient enrichment, making them ideal for monitoring eutrophication. Additionally, periphyton can bioaccumulate heavy metals, serving as an

ANSWERS

1. (A) Raymond F. Dasmann
Raymond F. Dasmann, a noted conservation biologist, originally introduced the term biological diversity to the scientific community in his nineteen seventy-three book. This phrasing was subsequently contracted to biodiversity during the mid-nineteen eighties. His early work laid critical conceptual foundations for modern conservation planning and global biological resource management.

2. (C) Genetic diversity
Genetic diversity represents the variety of genes and heritable characteristics within a species population. It provides the crucial raw material needed for evolutionary adaptation and natural selection over generations. Without sufficient heritable variation, populations cannot adapt to changing environmental conditions, which ultimately limits speciation processes and increases vulnerability to extinction.

3. (A) Walter G. Rosen
Walter G. Rosen coined the contracted term biodiversity while planning the landmark National Forum on BioDiversity held in nineteen eighty-six. This contraction simplified the broader term biological diversity for communication purposes. The event and the subsequent publication of its proceedings popularized the term among scientists, policymakers, and the general public worldwide.

4. (D) The variation in habitats, biotic communities, and ecological processes
Ecosystem diversity refers to the variety of distinct habitats, biological communities, and ecological processes within a specific geographic area. In aquatic contexts, this includes the complex interactions between organisms and physical elements across varied environments like lakes, rivers, wetlands, and oceans. It reflects structural complexity and ecological functions operating at a broad scale.

5. (B) It causes random fluctuations in allele frequencies, reducing diversity
Genetic drift is a microevolutionary force that drives random changes in allele frequencies within a population over time. This process is particularly pronounced in small, isolated aquatic populations where random events can easily eliminate rare alleles. Consequently, genetic drift leads to an overall reduction in genetic variation and increases the risk of inbreeding depression.

6. (C) Lower species diversity accelerates recovery from severe environmental stress
High species richness enhances community resilience and speeds up ecosystem recovery following disturbances. Diverse communities contain redundant species that can fill critical ecological niches if dominant species are lost. Conversely, ecosystems with low diversity lack these functional backups, which slows recovery times and makes the system highly susceptible to collapse under environmental stress.

7. (D) Ecosystem diversity
The structural complexity of a coral reef is a prime example of ecosystem diversity. Coral reefs provide highly heterogeneous physical architectures, creating unique niches, trophic webs, and biogeochemical processes. This physical complexity supports diverse biotic communities and complex interactions, illustrating variation at the ecosystem level rather than just the species or genetic level.

8. (A) It categorizes species based on their ecological roles and traits
Functional diversity assesses the range of ecological roles, behaviors, and physiological traits exhibited by species within an ecosystem. Unlike species diversity, which merely counts taxonomic units, functional diversity evaluates how species perform within the community. This approach helps ecologists understand ecosystem processes, resource utilization efficiency, and overall resilience to environmental disturbances.

9. (B) Global Biodiversity Hotspots concept - Norman Myers
Norman Myers introduced the global biodiversity hotspots concept in nineteen eighty-eight to identify areas of high endemism facing severe habitat loss. This framework revolutionized conservation prioritization by directing

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therapeutic compound for managing chronic and severe pain in patients.

88. (B) Deep-sea hydrothermal vents and hot springs
Taq polymerase was originally isolated from thermophilic bacteria found in hot springs and deep-sea hydrothermal vents. These extreme environments support organisms with highly stable enzymes that function at high temperatures. Bioprospecting these extremozymes has revolutionized molecular biology, enabling the development of polymerase chain reaction technology used worldwide.

89. (A) Production of unique phycocolloids like agar and alginate
Marine macroalgae are highly valued in bioprospecting due to their production of unique phycocolloids, such as agar, carrageenan, and alginate. These compounds possess exceptional gelling, emulsifying, and stabilizing properties. They are widely used in the food, pharmaceutical, and cosmetic industries, highlighting the commercial value of marine botanical resources.

90. (A) Both A and R are true and R is the correct explanation of A.
Marine sponges are a rich source of novel pharmaceutical compounds, often due to their symbiotic relationships with diverse microbial communities. These microbes synthesize many of the bioactive secondary metabolites formerly attributed to the host sponges. Both statements are correct, and the symbiotic relationship explains the high yield of bioactive compounds.

91. (B) Determine economic and ecological worth of resources to justify conservation
Valuation in bioprospecting seeks to estimate the economic and ecological worth of biological resources and ecosystem services. By quantifying these values, researchers can demonstrate the tangible benefits of preserving intact habitats. This economic justification helps policymakers balance short-term resource exploitation with long-term conservation and sustainable development goals.

92. (B) Limulus amebocyte lysate (LAL)
Limulus amebocyte lysate is a compound extracted from the blue blood of horseshoe crabs. It reacts with bacterial endotoxins, making it indispensable to the biomedical industry for testing the sterility of medical devices and injectable drugs. This high-value biochemical highlights the critical role of marine organisms in supporting human health.

93. (A) Aequorea victoria (jellyfish)
Green Fluorescent Protein was isolated from the bioluminescent jellyfish Aequorea victoria. This protein has become a revolutionary biomarker in molecular and cell biology, allowing researchers to visualize gene expression and cellular processes in real time. This discovery highlights the immense scientific and commercial value of marine bioprospecting.

94. (C) Chemical synthesis and marine microbial fermentation
Relying on wild harvesting to commercialize marine compounds can easily lead to the overexploitation of sensitive species. To ensure sustainability, researchers focus on chemical synthesis and marine microbial fermentation. These laboratory-based methods produce the target compounds without depleting natural populations or disrupting fragile marine ecosystems.

95. (A) Haematococcus pluvialis (microalga)
The freshwater microalga Haematococcus pluvialis hyper-accumulates high concentrations of astaxanthin under environmental stress conditions. This powerful carotenoid pigment is widely commercialized for its antioxidant properties and is used in human health supplements and aquaculture feeds to enhance pigmentation. Culturing this alga provides a sustainable source of the compound.

96. (B) Silica structures resembling commercial fiber optics
Deep-sea glass sponges of the genus Euplectella produce intricate silica skeletons with remarkable structural and optical properties. These biological structures resemble commercial fiber optics but are tougher and more flexible. Bioprospecting these sponges inspires materials scientists to design advanced, fracture-resistant glass and fiber-optic networks.

97. (A) Unauthorized appropriation of biological resources and traditional knowledge
Biopiracy refers to the unauthorized commercial exploitation of biological resources or traditional ecological knowledge without obtaining proper consent or providing fair compensation. This

117. (B) Withstand salinity fluctuations, migrating between fresh and marine waters
Euryhaline species possess highly adaptable osmoregulatory mechanisms that allow them to tolerate wide fluctuations in salinity. This physiological flexibility enables them to migrate between freshwater rivers and marine environments, as seen in species like the bull shark or barramundi, which exploit different habitats for feeding and reproduction.

118. (B) To escape high surface temperatures and visual predators
Many marine pelagic fish perform daily vertical migrations, moving to deeper, darker waters during the day. This behavior allows them to avoid the warm temperatures and high light levels of the surface, which reduces their metabolic costs and protects them from visual predators like seabirds and marine mammals.

119. (A) Biochemical Oxygen Demand (BOD) from organic pollution
Oxygen sag curves represent the characteristic spatial drop and subsequent recovery of dissolved oxygen in a river downstream from a waste discharge. This pattern is driven by high biochemical oxygen demand from organic pollution. Aerobic microbes consume oxygen as they decompose the organic waste, causing a localized drop in dissolved oxygen.

120. (A) I, II and IV
Temperature regulates biochemical reaction rates in ectotherms, alkalinity buffers against pH changes, and oxygen solubility decreases at higher salinities. However, high dissolved carbon dioxide decreases, rather than increases, water pH because it forms carbonic acid, which releases hydrogen ions and makes the water more acidic.

121. (B) Absorb disturbances and reorganize while retaining basic structure
Ecological resilience refers to the capacity of an ecosystem to absorb disturbances, such as pollution or overfishing, and reorganize while retaining its essential structure, function, identity, and feedbacks. A highly resilient aquatic system can withstand stress without shifting into a different, often degraded state.

122. (C) Threshold where small perturbation irreversibly alters ecosystem state
A tipping point represents a critical threshold in an ecosystem where a small additional perturbation can trigger rapid, dramatic, and often irreversible changes. Passing this point forces the system into a new state with different ecological structures and functions, making recovery to the original state extremely difficult.

123. (B) Fleshy macroalgae
A classic regime shift in coral reefs involves the transition from a coral-dominated system to one dominated by fleshy macroalgae. This shift is often triggered by the cumulative impacts of overfishing herbivorous fishes, nutrient pollution, and warming events. Once macroalgae dominate, they inhibit coral recruitment, locking the ecosystem into a degraded state.

124. (C) Seawater absorbing anthropogenic carbon dioxide, lowering its pH
Ocean acidification is driven by the absorption of anthropogenic carbon dioxide emissions from the atmosphere. When carbon dioxide dissolves in seawater, it forms carbonic acid, which reduces the pH of the ocean. This chemical shift alters the marine environment and threatens many organisms, particularly those that build shells and skeletons.

125. (B) Reduces availability of carbonate ions needed for skeleton formation
Ocean acidification lowers the concentration of carbonate ions in seawater. Calcifying marine organisms, such as corals and pteropods, rely on these ions to build and maintain their calcium carbonate shells and skeletons. The reduction in carbonate availability impairs calcification rates and can dissolve existing structures, threatening their survival.

126. (B) Alternative stable states and a regime shift
The abrupt transition of a shallow lake from a clear-water state dominated by macrophytes to a turbid state dominated by phytoplankton illustrates alternative stable states and a regime shift. Nutrient enrichment drives this shift, which is stabilized by positive feedbacks, making it difficult to return to the clear-water state.

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107. (B) Patenting a marine compound using indigenous knowledge without benefit-sharing
Patenting a marine compound developed from traditional ecological knowledge without obtaining consent or sharing commercial profits is a classic example of biopiracy. This practice exploits indigenous wisdom for corporate gain while offering no compensation to the community that preserved the resource, directly violating the principles of international conservation treaties.

108. (D) Plants and animals naturally occurring in the wild
Under the TRIPS agreement, member countries may exclude naturally occurring plants and animals from patentability to safeguard public interest and ecological integrity. However, microorganisms and non-biological processes can be patented. This distinction prevents the monopolization of wild biological resources while encouraging technical innovation in biotechnology.

109. (B) As temperature increases, DO capacity decreases
The relationship between water temperature and dissolved oxygen capacity is inversely proportional. As water temperature increases, the kinetic energy of water molecules rises, which reduces the solubility of gases. Consequently, warmer waters naturally hold less dissolved oxygen, which can cause respiratory stress in fish during hot seasons.

110. (C) I and II
Salinity strongly influences the osmoregulatory energy expenditure of fish, and low pH levels increase the toxicity of heavy metals like aluminum. However, high water temperatures increase, rather than decrease, fish metabolic rates because ectothermal organisms experience accelerated chemical reactions as their environmental temperature rises.

111. (A) Thermocline
The thermocline is a distinct thermal layer in a stratified water body where temperature changes rapidly with depth. Because temperature dictates density and oxygen levels, fish often position themselves relative to this boundary to find their optimal thermal and respiratory conditions, directly influencing their spatial distribution in lakes.

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112. (B) pH increases and temperature increases
Ammonia exists in water in two forms: toxic un-ionized ammonia and non-toxic ammonium. The chemical balance between these forms is highly dependent on pH and temperature. As both pH and temperature increase, the equilibrium shifts to favor the toxic un-ionized form, significantly increasing the risk of ammonia toxicity to fish.

113. (D) Aquatic surface respiration
When aquatic ecosystems experience severe hypoxia, many fish species exhibit aquatic surface respiration. They swim to the surface film where water is in direct contact with the atmosphere and holds slightly more oxygen. This behavioral adaptation allows them to survive temporary periods of low dissolved oxygen in stagnant waters.

114. (B) Forms a physiological barrier, restricting them to low-salinity reaches
High salinity in estuaries creates a severe osmoregulatory barrier for stenohaline freshwater fishes, which cannot tolerate significant osmotic changes. This physiological constraint prevents them from migrating into high-salinity zones, restricting their spatial distribution to the upper, freshwater-dominated reaches of the estuary where their internal ion balance can be maintained.

115. (B) Gill damage, mucus secretion, and osmoregulatory failure
Highly acidic water directly damages the delicate gill membranes of fish, triggering excessive mucus secretion and disrupting active ion transport. This disruption leads to severe osmoregulatory failure, as the fish can no longer maintain internal sodium and chloride concentrations, ultimately causing death in sensitive species.

116. (C) A narrow range of temperature tolerance
Stenothermal fish species are characterized by a narrow range of temperature tolerance. These organisms, such as trout and salmon, are highly specialized to survive only within specific, stable thermal limits. Small changes in water temperature can severely impact their physiological performance, growth, reproduction, and overall survival in the wild.

practice often involves patenting natural compounds or indigenous practices, which deprives provider countries and local communities of their rightful economic and legal benefits.

98. (A) The Earth Summit in Rio de Janeiro (1992)
The Convention on Biological Diversity was opened for signature at the United Nations Conference on Environment and Development, also known as the Earth Summit, in Rio de Janeiro in nineteen ninety-two. This landmark treaty established a global commitment to conserving biodiversity, promoting sustainable use, and ensuring equitable benefit sharing.

99. (B) Access and Benefit Sharing (ABS)
The Convention on Biological Diversity established the Access and Benefit Sharing mechanism to prevent biopiracy. This legal framework requires users of genetic resources to obtain prior informed consent and negotiate mutually agreed terms with the provider country. It ensures that benefits derived from bioprospecting are shared equitably with local communities.

100. (A) P-3, Q-1, R-2, S-4
These pairings align international treaties with their objectives. The Nagoya Protocol establishes a clear legal framework for Access and Benefit Sharing, while the TRIPS Agreement regulates global intellectual property standards. CITES controls international trade in endangered species, and the CBD commits nations to broader biodiversity conservation and sustainable use.

101. (A) Researchers must obtain permission from provider country and communities
Prior Informed Consent is a core requirement of the Nagoya Protocol. It dictates that researchers must obtain formal permission from the competent national authority of the provider country and local communities before accessing genetic resources or traditional knowledge. This mechanism ensures transparency and protects indigenous rights from biopiracy.

102. (B) Patenting of selectively bred or genetically modified fish strains
Intellectual Property Rights disputes in aquaculture frequently focus on patenting selectively bred fish strains, transgenic organisms, or specific genetic markers. Companies seek patents to protect their research investments, but this can restrict access for small-scale farmers and raise ethical concerns about monopolizing food resources and genetic biodiversity.

103. (A) Frequently held in public domain or passed down orally without patent
Traditional Ecological Knowledge is highly vulnerable to biopiracy because it is typically passed down orally and shared within communities without formal patent protection. Because this knowledge lacks written legal documentation in global patent registries, external corporations can easily exploit it to develop commercial products without acknowledging or compensating the original holders.

104. (A) Sovereign Rights Doctrine (as affirmed by the CBD)
The Sovereign Rights Doctrine, explicitly affirmed by the Convention on Biological Diversity, establishes that nations hold sovereign authority over their own biological resources. This principle shifted biological resources away from the common heritage framework, allowing countries to regulate access and negotiate fair benefit-sharing agreements for their genetic wealth.

105. (D) Conditions of access and how benefits will be shared between parties
Mutually Agreed Terms are legal contracts negotiated between the providers and users of genetic resources. Under the Nagoya Protocol, these agreements define the specific conditions under which biological materials can be accessed and detail how any resulting commercial, scientific, or financial benefits will be shared between the involved parties.

106. (D) Plants and animals naturally occurring in the wild
The TRIPS Agreement allows WTO members to exclude plants and animals (other than microorganisms) from patentability. However, microorganisms and certain microbiological processes may be patented. This provision protects biodiversity, ethical concerns, and public interest while encouraging innovation in biotechnology through limited patent protection for eligible inventions.

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127. (A) Age-truncation of large, old, and highly fecund individuals
Heavy fishing pressure often results in age-truncation, where large, old individuals are selectively removed from the population. These older individuals are highly fecund and produce high-quality larvae. Losing them reduces the demographic diversity of the stock, impairing reproductive success and undermining the ecological resilience of the fishery.

128. (B) Saltwater intrusion shifting freshwater and halophytic communities
Sea level rise impacts estuarine ecosystems by driving saltwater intrusion further upstream. This increased salinity alters the physical environment, shifting the boundaries between freshwater and halophytic communities. Sensitive freshwater species are displaced, while salt-tolerant species expand their range, restructuring the entire estuarine biological community.

129. (B) Recovery threshold harder to reach than the degradation threshold
Hysteresis in aquatic ecosystems occurs when the pathway for recovery from a degraded state differs from the pathway of degradation. This means that reversing the stressor to the level where the collapse occurred is often insufficient for recovery; the stressor must be reduced significantly further to return the system to its original state.

130. (A) I, II and IV
Warmer waters hold less oxygen, marine heatwaves trigger coral bleaching, and stratification restricts vertical nutrient mixing. However, increased carbon dioxide levels impair, rather than enhance, the calcification rates of marine bivalves due to ocean acidification. Additionally, climate velocity shifts fish distributions, but not all species can keep pace with these changes.

131. (A) Zooxanthellae (dinoflagellates)
Coral bleaching is the breakdown of the obligate symbiotic relationship between the host coral animal and its photosynthetic zooxanthellae. Under elevated water temperatures or light stress, corals expel these colorful algae, revealing their white calcium carbonate skeletons. Without these symbionts, corals lose their primary energy source, leading to starvation and mortality.

132. (D) Diverse, asynchronous dynamics of multiple subpopulations
The portfolio effect stabilizes ecological communities through the diverse, asynchronous dynamics of multiple subpopulations or species. Similar to a diversified financial portfolio, this variation buffers the overall population against localized environmental fluctuations. It ensures consistent productivity and enhances the ecological resilience of the broader aquatic system over time.

133. (B) Disproportionately large environmental impact relative to abundance
A cornerstone species is defined by its disproportionately large impact on community structure and function relative to its physical abundance or biomass. The removal of a keystone species can trigger dramatic trophic cascades and restructure the entire ecosystem, demonstrating its critical role in maintaining biological diversity and community stability.

134. (B) Sea Otter
The sea otter is a classic keystone species in kelp forest ecosystems. By preying on herbivorous sea urchins, otters prevent these grazers from overconsuming the kelp canopy. Without otters, urchin populations expand rapidly, creating urchin barrens and destroying the complex kelp habitat that supports diverse marine communities.

135. (C) Flagship species
The Ganges River Dolphin serves as a classic flagship species. It is a highly charismatic mammal used in conservation campaigns to capture public attention, raise funds, and generate political support. By leveraging public empathy for this iconic animal, conservationists can implement broader river restoration programs that benefit the entire freshwater ecosystem.

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136. (A) Its protection indirectly protects many other species in the habitat
An umbrella species is selected for conservation planning because it has large home ranges and complex habitat requirements. Protecting the extensive, high-quality habitats needed to sustain a viable population of this species automatically protects numerous other sympatric species that share the same ecosystem, making conservation efforts highly efficient.

137. (D) Requires extensive, connected, and pristine river networks
The Golden Mahseer is an effective umbrella species because it requires extensive, connected, and clean river systems to complete its life cycle and migration. By protecting the large river networks necessary for this migratory fish, conservationists automatically preserve the habitats and water quality required by many other resident freshwater species.

138. (A) Infer the environmental condition or health of a specific habitat
Indicator species are utilized to assess and infer environmental conditions or ecological changes within a specific habitat. Because these species have known tolerances to environmental variables like temperature, pollution, or flow, monitoring their presence, absence, or abundance provides a reliable measure of ecosystem health and water quality.

139. (A) Their habitat needs may not perfectly overlap with cryptic or specialized endemic species
A primary limitation of relying solely on charismatic flagship species is that their ecological requirements may not overlap with those of less visible, specialized, or endemic species. Consequently, protecting the habitat of a flagship species might fail to conserve cryptic organisms that rely on unique microhabitats or specific environmental conditions.

140. (D) A is false but R is true.
Protecting an umbrella species does not guarantee the survival of all sympatric endemic species. These organisms do not always share identical microhabitat requirements or environmental tolerances. Therefore, the assertion is false, as localized endemics may still decline if their specific microhabitats are neglected within the larger protected area.

141. (B) Accumulation of pollutants via filter feeding
Bivalves, such as oysters and mussels, are highly effective indicator species in coastal ecosystems because they are sessile filter feeders. As they process large volumes of water, they accumulate pollutants, heavy metals, and microplastics in their tissues. Analyzing these tissues provides a reliable measure of localized water contamination levels.

142. (B) Assam
The Ganges River Dolphin is the official state aquatic animal of Assam, serving as a powerful symbol for freshwater conservation. Inhabiting the Brahmaputra River system, this endangered mammal helps raise public awareness and drive conservation initiatives aimed at restoring river health and protecting endemic aquatic species across the region.

143. (B) Ecosystem engineer
An ecosystem engineer is a species that physically modifies, creates, or maintains habitats, directly influencing the availability of resources for other organisms. Classic examples include beavers, which build dams that create wetlands, and reef-building corals, which construct complex three-dimensional structures that support diverse marine communities.

144. (C) Flagship species
The flagship species concept relies on socio-economic, cultural, and aesthetic appeal rather than strict ecological function. These species are chosen to serve as ambassadors for conservation campaigns because they capture public imagination and empathy, helping to secure funding and political support that can then be applied to broader ecosystem management.

145. (A) Align regional pride with conservation of native fish
The State Fish initiative in India was launched to align regional pride with the conservation of native aquatic species. By designating an iconic, locally valuable fish as a state symbol, the program raises public awareness, fosters community ownership, and directs governmental funding and research toward restoring local populations and habitats.

146. (D) Tor putitora (Golden Mahseer)
The Golden Mahseer is designated as the State Fish of several Indian states, including Arunachal Pradesh, Himachal Pradesh, and Uttarakhand. This iconic cold-water cyprinid is celebrated for its cultural, ecological, and recreational value. Its official status helps drive conservation efforts across the fast-flowing streams of the Himalayan region.

147. (A) Etroplus suratensis (Pearl Spot / Karimeen)
Kerala declared the Pearl Spot, locally known as Karimeen, as its State Fish. This endemic

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cichlid is highly valued for both its commercial aquaculture potential and its culinary significance in the region's backwaters. Its designation aims to promote sustainable farming, habitat protection, and the conservation of wild populations.

148. (D) Tenualosa ilisha (Hilsa)
The State Fish of West Bengal is the Hilsa, an anadromous clupeid highly celebrated for its culinary value and cultural importance. Migrating from marine environments to freshwater rivers to spawn, this species faces threats from overfishing and barriers like dams, making its state designation crucial for driving regional conservation policies.

149. (A) Clarias magur (Magur)
Bihar designated the air-breathing walking catfish, Clarias magur, as its State Fish. This highly nutritious native species is adapted to swampy and hypoxic environments. Its official status is intended to promote local aquaculture, discourage the illegal farming of invasive catfishes, and conserve wild populations in the state's wetlands.

150. (A) P-2, Q-1, R-3, S-4
These matches align Indian states with their declared State Fish. Odisha is represented by the Mahanadi Mahseer, Telangana by the Murrel, Manipur by the endemic Pengba, and Tripura by the Pabda catfish. These designations highlight the diverse ecological and cultural values of native fishes across different regions of India.

151. (B) Ithai Barrage preventing its potamodromous migration
The population of Pengba in Loktak Lake declined sharply following the construction of the Ithai Barrage. This barrier blocked the fish's potamodromous migration routes between the lake and the Chindwin-Irrawaddy river system, disrupting its life cycle and preventing natural spawning. This impact highlights how river fragmentation threatens endemic species.

152. (D) Channa striata (Murrel)
Andhra Pradesh designated the striped snakehead, Channa striata, also known as Murrel, as its State Fish. This air-breathing predator is highly popular in regional aquaculture and wild fisheries due to its firm flesh and medicinal value. Its designation helps support sustainable farming practices and the restoration of natural freshwater wetlands.

153. (B) Nagaland
Nagaland designated the Chocolate Mahseer, Neolissochilus hexagonolepis, as its State Fish. This species is native to the fast-flowing streams of the northeastern hills. Its official status is vital for raising local awareness against destructive fishing methods, such as dynamiting or poisoning, and for protecting these pristine river systems.

154. (B) Triggers targeted funding, restoration, and awareness programs
Declaring a species as a State Fish triggers targeted funding, dedicated restoration initiatives, and public awareness campaigns. This policy tool elevates the conservation status of native species, enabling state fisheries departments to secure resources for habitat restoration, captive breeding, and community-based management programs designed to protect wild populations.

155. (B) Gujarat
Gujarat declared the Ghol fish, also known as the blackspotted croaker, as its State Fish in twenty twenty-three. This high-value marine species is prized for its culinary quality and its swim bladder, which is used in cosmetics and pharmaceuticals. The designation aims to boost coastal fisheries management and promote sustainable harvesting.

156. (D) Clown Knifefish / Moy
The State Fish of Uttar Pradesh is Chitala chitala, commonly known as the Clown Knifefish or Moy. This distinctive, predatory freshwater species is recognized by its laterally compressed body and small scales. Its designation emphasizes the need to conserve large river systems and restore native fish populations across the state.

157. (A) River damming and barrage construction
Habitat fragmentation in flowing river ecosystems is driven by the construction of dams and barrages. These physical barriers disrupt the ecological continuity of the river, isolating fish populations and blocking migratory pathways. This fragmentation prevents species from accessing spawning grounds and limits genetic exchange, which can lead to localized extinctions.

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178. (D) Trophic cascade leading to extinction of endemic cichlid species
The introduction of the Nile perch into Lake Victoria triggered a classic trophic cascade. As a large, top predator, it preyed heavily on the lake's diverse, endemic haplochromine cichlids, driving hundreds of unique species to extinction. This ecological collapse altered the entire food web and simplified the lake's ecosystem structure.

179. (A) Pathogen pollution / Enemy release
Pathogen pollution occurs when an invasive alien species introduces a novel disease or parasite to which native species have no evolutionary immunity. This disease transmission can trigger rapid, widespread mortality in native populations, while the invader remains unaffected, facilitating its rapid establishment and spread within the novel environment.

180. (B) Bioturbation; uprooting plants and increasing turbidity while foraging
The common carp alters benthic habitats through bioturbation. As it root-feeds in the sediment for invertebrates, it uproots submerged macrophytes and resuspends benthic nutrients and fine sediments. This foraging behavior increases water turbidity, which blocks sunlight, reduces primary productivity, and degrades water quality for native species.

181. (A) High levels of plant endemism and significant habitat loss
Norman Myers established the global biodiversity hotspots framework using two key criteria: high levels of plant endemism and significant habitat loss. To qualify, a region must host a large concentration of endemic vascular plants, serving as a proxy for overall biodiversity, and have lost most of its original natural vegetation.

182. (B) Must have lost at least 70% of its original native habitat
To qualify as a global biodiversity hotspot under Conservation International criteria, a region must contain at least fifteen hundred endemic vascular plant species and have lost at least seventy percent of its original native vegetation. This threshold highlights areas of exceptional biodiversity that are under extreme threat of imminent destruction.

183. (A) The Western Ghats and Sri Lanka
The Western Ghats and Sri Lanka is officially recognized as a global biodiversity hotspot. This region features exceptional levels of endemism across diverse taxa, particularly freshwater fishes, amphibians, and plants. However, the ecosystem faces severe pressure from habitat fragmentation and urbanization, making targeted conservation efforts critical for its survival.

184. (D) Mekong River and Brahmaputra River systems
The Indo-Burma biodiversity hotspot covers parts of North-East India and is drained by major river systems like the Mekong and Brahmaputra. These complex river networks support rich aquatic fauna, including diverse endemic fishes and turtles. Protecting these watersheds is essential for conserving the unique freshwater biodiversity of this global hotspot.

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185. (B) Single Large Or Several Small
The SLOSS debate in conservation biology stands for Single Large Or Several Small protected areas. It addresses whether it is ecologically better to protect a single, large contiguous reserve or several small reserves of equal total area. The debate considers factors like edge effects, migration corridors, and extinction risks for target species.

186. (C) The Coral Triangle (Indo-Pacific)
The Coral Triangle is recognized as the global epicenter of marine biodiversity. This region supports the highest concentration of reef-building corals, seagrasses, and reef-associated fishes on Earth. Its exceptional species richness and endemism make it a top priority for international marine conservation and spatial planning initiatives.

187. (A) Expansion of oil palm plantations and mangrove clearance
The Sundaland hotspot, which includes the Nicobar Islands, faces severe ecological threats from the expansion of oil palm plantations and agricultural encroachment. This development leads to widespread mangrove clearance and coastal habitat degradation, which increases sedimentation in coastal waters and threatens delicate marine and estuarine ecosystems.

168. (C) Destroying benthic habitats and generating massive unselective bycatch
Bottom trawling is a highly destructive fishing practice that drags heavy nets across the seafloor. This method physically flattens benthic habitats, destroying complex structures like cold-water corals and sponge gardens. Additionally, it generates massive, unselective bycatch of non-target species, severely disrupting benthic community dynamics.

169. (A) Non-native species causing harm or threatening health in new environments
An invasive alien species is a non-native organism that establishes self-sustaining populations and causes ecological, economic, or health harm in its new environment. These species outcompete native taxa, alter habitat structures, and disrupt local food webs, serving as a primary driver of global biodiversity loss.

170. (A) II → I → III → IV
The biological invasion process follows a structured sequence. It begins with the introduction of a non-native species outside its natural range. The species then establishes a self-sustaining population. Next, it spreads to new habitats within the region, and finally, it causes significant ecological impacts and disruptions to local food webs.

171. (C) Aggressive omnivore with accessory respiration allowing survival in mud
The African catfish is a highly invasive species in Indian waters. Its success is driven by its aggressive, omnivorous feeding behavior and its accessory breathing organs, which allow it to survive in hypoxic, muddy waters. These traits enable it to outcompete and prey upon diverse native fishes.

172. (D) Prolific breeding, parental care, and intense resource competition
The Mozambique tilapia is a highly successful invader due to its prolific breeding capacity, strong parental care (mouthbrooding), and tolerance to environmental extremes. These traits enable it to establish dense populations quickly, outcompeting native fishes for food and nesting sites, which often leads to a decline in indigenous biodiversity.

173. (A) The Western Atlantic and Caribbean Sea
The red lionfish has caused severe ecological disruption across the Western Atlantic and Caribbean Sea. Lacking natural predators in this invaded region, its voracious appetite allows it to deplete native reef fish populations rapidly. This predation pressures coral reef communities and undermines the stability of local marine food webs.

174. (B) Discharge of ship ballast water
The discharge of ship ballast water is a major vector for the accidental introduction of marine invasive species. Cargo ships take on water for stability, taking in diverse plankton, larvae, and small organisms. When this water is discharged at destination ports, these non-native species are introduced to new marine ecosystems.

175. (B) Surface mats blocking sunlight and oxygen exchange, causing hypoxia
The invasive water hyacinth forms dense floating mats on the water surface. These mats block sunlight, preventing the photosynthesis of submerged plants, and restrict atmospheric oxygen exchange. The subsequent decomposition of dying vegetation depletes dissolved oxygen levels, causing severe hypoxia that can lead to large-scale native fish mortality.

176. (B) Pygocentrus nattereri (Red-bellied piranha) / Pacu variants
The illegal introduction of predatory species like the red-bellied piranha and pacu variants poses a severe threat to native carps. These aggressive, opportunistic predators prey directly on indigenous species. Their introduction disrupts freshwater food webs and undermines aquaculture security and the conservation of native riverine biodiversity.

177. (D) Loss of unique endemics and replacement by adaptable non-natives
Biotic homogenization refers to the process where unique, endemic species are lost and replaced by a few widespread, highly adaptable non-native species. This ecological transition reduces the biological distinctiveness between different regions, leading to uniform species compositions and a loss of regional beta diversity across aquatic ecosystems.

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158. (B) Blocking migration routes to freshwater spawning grounds
Dams threaten anadromous fishes, such as the Hilsa, by blocking their upstream migration from the sea to freshwater spawning grounds. These barriers fragment the river network, preventing adult fish from reproducing and leading to a collapse in recruitment. Restoring river connectivity is essential for the long-term survival of these species.

159. (A) Targeting lower trophic levels as high-trophic predators are depleted
Fishing down marine food webs occurs when intensive fisheries deplete populations of large, high-trophic-level predatory fishes. As these top predators decline, fleets shift their targeting to smaller, short-lived species at lower trophic levels. This ecological transition simplifies marine food webs and can lead to the instability of entire marine ecosystems.

160. (B) I → III → IV → II
This sequence represents the typical progression of human impacts on a river ecosystem. It begins with the overharvesting of top predators, followed by habitat fragmentation from dam construction. Next, agricultural intensification drives eutrophication, and finally, the introduction of non-native species further alters and disrupts the remaining native community.

161. (B) Altering metabolic rates, premature spawning, and localized hypoxia
Thermal pollution from industrial cooling discharges alters the ambient temperature of aquatic habitats. This warming increases the metabolic rates of ectothermic fish while reducing dissolved oxygen solubility, which can cause localized hypoxia. It can also trigger premature spawning or thermal shock, disrupting the life cycles of resident species.

162. (C) Oxygen depletion from microbial decomposition of dying algae
Eutrophication caused by phosphorus runoff triggers rapid algal blooms. When these massive algal mats die, aerobic microbes decompose the organic matter, consuming vast amounts of dissolved oxygen in the process. This microbial respiration leads to severe hypoxia, causing massive fish kills and simplifying the biological community.

163. (D) Shift geographical range to escape localized toxic zones
The synergistic combination of chemical pollution and habitat fragmentation severely restricts a fish's ability to migrate away from degraded areas. Physical barriers, such as dams or channelization, trap populations within contaminated river reaches, preventing them from shifting their range to find cleaner, more suitable habitats elsewhere in the watershed.

164. (A) Phase shift of the reef from coral-dominated to macroalgae-dominated
Overfishing herbivorous reef fishes, such as parrotfish, removes the primary grazers that control algae. Without these herbivores, fleshy macroalgae grow rapidly, outcompeting corals for space and light. This leads to a phase shift from a coral-dominated reef to a degraded, macroalgae-dominated system, reducing overall marine biodiversity.

165. (A) Bypassing natural channels through tunnels, leaving stretches dry
Run-of-the-river hydroelectric projects in the Himalayas often divert water through long tunnels to generate power before returning it downstream. This diversion bypasses natural river channels, leaving significant stretches of the river dry or with severely reduced flows, which destroys critical habitats for cold-water fishes.

166. (D) Originating from a single, identifiable source, such as a factory effluent pipe
Point-source pollution is characterized by discharging contaminants from a single, easily identifiable source, such as a factory pipe or municipal wastewater treatment plant. This localized discharge makes point sources easier to monitor, regulate, and control compared to diffuse, non-point source pollution like agricultural runoff.

167. (A) Concentration of toxins on plastics increases at higher trophic levels
Microplastic biomagnification occurs as plastic particles and their adsorbed chemical toxins are transferred up the food web. When predators consume prey containing microplastics, these contaminants accumulate in their tissues. Consequently, the concentration of toxic substances increases at higher trophic levels, posing severe health risks to top predators.

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188. (D) Impacted by water extraction, pollution, and fragmentation in watersheds
Freshwater ecosystems within global hotspots are highly threatened because they are concentrated within watersheds heavily impacted by human activities. Water extraction, chemical pollution, and habitat fragmentation from dams alter these systems directly. Because freshwater organisms are confined to connected waterways, they cannot easily escape these localized impacts.

189. (A) Identify biodiversity unrepresented in existing protected areas
Gap analysis is a spatial planning method used to identify species, ecosystems, or habitats that are not adequately represented within an existing network of protected areas. By overlaying biodiversity distribution maps with maps of protected boundaries, conservationists can identify critical gaps and prioritize new areas for legal protection.

190. (C) A is true but R is false.
The hotspot concept successfully prioritizes regions to maximize the protection of endemic species per dollar spent. However, the statement that hotspots cover only two point five percent of Earth's land surface but host over half of all plant species is incorrect; the actual percentage and species coverage values differ under current assessments.

191. (A) Select sites containing unrepresented species to maximize protection
Complementarity is a core principle of systematic conservation planning. It involves selecting new protected sites that contain species or habitats not already represented within the existing reserve network. This approach ensures that conservation funding is used efficiently to maximize the total number of protected species across the region.

192. (A) High numbers of invasive species
Norman Myers' initial hotspot designation was based on high floristic endemism and extreme habitat loss. The presence of high numbers of invasive species was not a criterion for selection. The framework focuses on identifying areas of exceptional native biodiversity that are facing severe and imminent threats from human activities.

193. (D) Partially Threatened (PT)
Partially Threatened is not an official category within the IUCN Red List assessment framework. The established categories include Vulnerable, Near Threatened, Critically Endangered, Endangered, and Least Concern. These categories are assigned based on rigorous, standardized quantitative criteria designed to evaluate a species' risk of extinction in the wild.

194. (D) Known only to survive in cultivation, captivity, or as naturalized
A species is classified as Extinct in the Wild when exhaustive surveys in its historical habitat have failed to record a single individual. The taxon is only known to survive in captivity, in cultivation, or as a naturalized population well outside its past range, indicating it no longer functions in its natural ecosystem.

195. (C) Reduction in population size over 10 years or 3 generations
Criterion A of the IUCN Red List evaluates a reduction in population size over a timeframe of ten years or three generations, whichever is longer. This assessment can be based on direct observation, index of abundance, or levels of exploitation, providing a standardized measure of rapid population decline across diverse taxa.

196. (A) Specific area within the EOO where the taxon physically occurs
Area of Occupancy is defined as the specific area within the broader Extent of Occurrence where the taxon physically occurs. While Extent of Occurrence measures the outer boundary enclosing all known populations, Area of Occupancy accounts for habitat discontinuities, reflecting the actual space occupied by the species.

197. (C) 90%
To be listed as Critically Endangered under Criterion A, a species must experience a population reduction of at least ninety percent over ten years or three generations. This threshold applies when the causes of the decline are clearly identified, understood, reversible, and have ceased, representing an extreme risk of imminent extinction.

198. (A) Data Deficient (DD)
A species is categorized as Data Deficient when there is inadequate information to make a direct

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or indirect assessment of its risk of extinction based on its distribution or population status. This label indicates that more research is required before the taxon can be assigned to a specific threat category.

199. (A) Population Viability Analysis (PVA)
Criterion E of the IUCN Red List relies on quantitative analysis to estimate the probability of extinction. The primary modeling tool used for this is Population Viability Analysis. This method integrates demographic, genetic, and environmental data to project future population trends and calculate the likelihood of extinction over a specified timeframe.

200. (A) P-4, Q-2, R-3, S-1
These matches align IUCN Red List categories with their defining conditions. Least Concern represents widespread, abundant taxa, while Near Threatened denotes species close to qualifying for a threatened category. Endangered represents species facing a very high risk of extinction, and Vulnerable indicates species facing a high risk in the wild.

201. (C) Population size
In the IUCN framework, population size is defined as the total number of mature individuals capable of reproduction. This metric is critical because it reflects the reproductive capacity of the taxon. Excluding non-reproductive juveniles or senescent individuals provides a more realistic estimate of a species' demographic stability and resilience.

202. (A) Scales the timeframe for population reduction to life history
Generation length is important in IUCN assessments because it scales the timeframe for population reduction to the specific life history of the species. This ensures that slow-growing, late-maturing organisms are evaluated over longer periods than rapid-breeding species, providing a biologically meaningful measure of extinction risk.

203. (C) Small population size combined with an ongoing decline
Criterion C of the IUCN framework is triggered when a species has a small population size of mature individuals combined with an ongoing, documented decline. This criterion focuses on the vulnerability of small populations to stochastic events and demographic instability, which can accelerate their path toward extinction.

204. (A) A species has not yet been evaluated against the IUCN criteria
The category Not Evaluated is applied to species that have not yet been assessed against the standardized IUCN Red List criteria. This designation indicates that the taxon has not undergone the formal review process, often due to a lack of resources or taxonomic prioritization by specialist groups.

205. (A) Evaluate regional taxa using IUCN criteria and propose actions
The primary objective of a Conservation Assessment and Management Plan workshop is to evaluate the conservation status of regional taxa using the standardized IUCN Red List criteria. These collaborative meetings bring together scientists, managers, and stakeholders to assess threats, assign threat categories, and draft actionable conservation recommendations.

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206. (A) Taxon Data Sheet
The Taxon Data Sheet is a key tool used during CAMP workshops to facilitate decision-making. It compiles all available scientific and grey literature on a species' taxonomy, distribution, population trends, and threats. This standardized format allows experts to systematically evaluate the taxon against IUCN criteria and document their reasoning.

207. (D) Conservation Breeding Specialist Group (CBSG) of the IUCN SSC
CAMP workshops are coordinated globally by the Conservation Breeding Specialist Group, now known as the Conservation Planning Specialist Group, of the IUCN Species Survival Commission. This network provides the methodology, facilitation expertise, and standardized tools required to conduct rapid, participatory conservation assessments across diverse taxonomic groups.

208. (A) Habitat degradation, flow alteration, and invasive species
Regional CAMP workshops for freshwater fishes of India consistently identify habitat degradation, flow alteration from dams, and invasive species as the primary threats to native fish diversity. These human activities disrupt aquatic ecosystems, fragment breeding grounds,

and outcompete native species, driving many endemic taxa toward extinction.

209. (B) Integrated with scientific data to estimate population trends
During CAMP workshops, traditional ecological knowledge from local fisher communities is integrated with scientific data to estimate population trends and historical distributions. This participatory approach captures valuable local observations of species declines, spawning locations, and habitat changes, filling critical data gaps where formal scientific studies are lacking.

210. (B) II and III
CAMP workshops follow a rapid, participatory, and scientifically rigorous process to evaluate species. They produce valuable recommendations for research, conservation, and management. However, they do not focus purely on ex situ protocols; rather, they evaluate both in situ and ex situ needs to support comprehensive conservation planning.

211. (A) Formulating species-specific Conservation Action Plans (CAPs)
Formulating species-specific Conservation Action Plans is a key outcome of a CAMP workshop. This process bridges taxonomic assessment with on-the-ground action by defining priority research areas, habitat restoration goals, and policy interventions. These plans guide conservation agencies and NGOs in implementing targeted measures to protect threatened species.

212. (D) Endangered
A species with an Extent of Occurrence of less than five thousand square kilometers that is highly fragmented and experiencing continuous decline meets the threshold for Endangered under IUCN Criterion B. This categorization reflects a high risk of extinction in the wild, requiring urgent conservation intervention.

213. (D) Unregulated introduction of the species into foreign watersheds
A management plan developed during a CAMP workshop would not recommend the unregulated introduction of a species into foreign watersheds. Such introductions can disrupt local food webs and introduce diseases. Instead, plans focus on establishing sanctuaries, implementing sustainable fishing regulations, and conducting structured captive breeding for reintroduction.

214. (A) Cryptic habitats and difficulty in obtaining abundance data
Assessing aquatic species during CAMP workshops is challenging due to their cryptic underwater habitats and the difficulty of obtaining reliable abundance data. Unlike terrestrial mammals, which can often be counted visually, monitoring fish populations requires specialized sampling gear and modeling, which introduces significant uncertainty into assessments.

215. (A) Prioritized inclusion in Indian Wildlife (Protection) Act Schedules
A key success of regional CAMP workshops in India has been identifying threatened aquatic species for prioritized inclusion in the schedules of the Indian Wildlife (Protection) Act. This legal designation provides species with strict national protection, outlawing wild harvest and driving targeted enforcement and habitat conservation.

216. (D) The 'Silo effect' where stakeholders do not share critical data
The collaborative structure of CAMP workshops helps overcome the silo effect, where researchers, government officials, and NGOs fail to share critical data. By bringing these stakeholders together in a participatory environment, the workshop facilitates data sharing, builds consensus on species status, and fosters collaborative conservation actions.

217. (A) Natural surroundings
In situ conservation involves protecting ecosystems and natural habitats to maintain viable populations of species in their natural surroundings. This approach preserves the evolutionary processes, ecological interactions, and habitat structures that sustain species over time, making it the preferred strategy for long-term biodiversity conservation.

218. (D) All forms of extractive activities are strictly prohibited
A No-Take Zone within a Marine Protected Area operates under the principle that all forms of resource extraction are strictly prohibited. This includes commercial and recreational fishing, mining, and coastal development. This strict protection allows marine communities to

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recover, supporting natural age structures and high spawning biomass.

219. (A) Outward migration of fish into adjacent unprotected grounds
The spillover effect refers to the outward migration of adult fish and larvae from a protected No-Take Zone into adjacent, unprotected fishing grounds. As populations inside the reserve recover and expand, individuals migrate across boundaries to escape competition, which helps support local fisheries outside the MPA.

220. (A) I, III and IV
Biosphere Reserves consist of a strictly protected core zone and a buffer zone that allows for sustainable resource use and research. They are designated internationally under UNESCO's Man and the Biosphere program. However, they do not exclude human communities; instead, they integrate local populations within the transition zone.

221. (A) Cultural and religious taboos naturally enforce non-fishing norms
Riverine fish sanctuaries in India are often located near religious sites because cultural and religious taboos naturally enforce non-fishing norms. These temple sanctuaries protect fish from harvesting, creating effective, community-managed refuges that preserve adult spawning stocks and genetic diversity without requiring formal government enforcement.

222. (D) Dugong (Sea Cow)
The Gulf of Mannar Biosphere Reserve is a critical site for the in situ conservation of the Dugong, or sea cow. This vulnerable marine mammal relies on the extensive seagrass beds found in the shallow waters of the reserve. Protecting these habitats is essential for its survival and foraging needs.

223. (A) Connectivity makes MPAs vulnerable to upstream pollution and dams
Establishing freshwater protected areas is challenging because high hydrological connectivity makes them vulnerable to upstream impacts. Activities outside the reserve, such as agricultural runoff, chemical pollution, or dam construction, flow directly into the protected reach, undermining local conservation efforts in ways that are less common in marine systems.

224. (A) National Chambal Sanctuary
The National Chambal Sanctuary is a critical in situ conservation site in India. It protects the critically endangered Gharial, the Ganges River Dolphin, and various rare freshwater turtle species. The sanctuary preserves a pristine stretch of the Chambal River, maintaining the sandbanks and water quality required for nesting.

225. (A) Essential Fish Habitat (EFH)
Marine Protected Areas designed to protect critical life-history stages focus on Essential Fish Habitats. These areas include spawning grounds, larval nurseries, and migration corridors. Protecting these habitats is crucial for sustaining fish populations, as it safeguards individuals during their most vulnerable developmental phases.

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226. (A) Transition Zone
The transition zone is the outermost area of a Biosphere Reserve. In this zone, local communities, conservation agencies, and scientists collaborate to manage resources sustainably. It accommodates agricultural activities, settlements, and sustainable development initiatives, demonstrating how human activities can coexist with biodiversity conservation.

227. (A) No-take, Enforced, Old, Large, Isolated
The NEOLI features are key drivers of MPA effectiveness. They stand for No-take, Enforced, Old, Large, and Isolated. Marine reserves that possess these five characteristics tend to host significantly higher fish biomass, species richness, and conservation value compared to smaller, open, or poorly enforced protected areas.

228. (B) Dynamic Ocean Management
Dynamic Ocean Management is an in situ conservation strategy that utilizes real-time oceanographic data to shift protected boundaries. This approach tracks highly mobile pelagic species, such as sea turtles and tuna, and adjusts fishing closures dynamically, minimizing bycatch while reducing the economic impact on commercial fisheries.

229. (A) Conservation of components of biological diversity outside their natural habitats
Ex situ conservation refers to the preservation of biological diversity outside its natural habitat. This strategy includes maintaining live

specimens in aquaria, botanical gardens, or live gene banks, as well as cryopreserving genetic material. It serves as a vital backup for species facing extreme threats in the wild.

230. (A) I, II and IV
Live gene banks maintain captive populations of endangered species to preserve genetic diversity for future reintroductions. However, these programs face challenges from inbreeding and genetic drift. Additionally, they are highly vulnerable to disease outbreaks and are more expensive to maintain long-term than cryogenic gene banks.

231. (B) Produce stock for restorative ranching to supplement populations
The primary goal of captive breeding for endangered fishes like the Golden Mahseer is to produce healthy stock for restorative ranching. Releasing these captive-bred juveniles into degraded rivers helps supplement depleted wild populations, restore ecological balance, and support the recovery of the species in its native range.

232. (A) Domestication selection and founder effects
A major genetic concern in captive breeding programs is the loss of wild adaptive traits due to domestication selection and founder effects. Captive environments favor individuals adapted to artificial feeds and crowding, which can reduce the evolutionary fitness and survival of their offspring when released back into the wild.

233. (D) Public education and providing facilities for breeding and rescue
Public aquaria support ex situ conservation through education and research. They raise public awareness about aquatic biodiversity, fund field conservation, and provide specialized facilities for breeding endangered species and rescuing injured marine wildlife, serving as a bridge between the public and active conservation science.

234. (A) Factorial mating designs and pedigree tracking
To maintain effective population size and minimize inbreeding, live gene banks employ factorial mating designs and pedigree tracking. This approach pairs individuals based on genetic distance, ensuring that all breeders contribute equally to the next generation. It preserves genetic variation and prevents the accumulation of deleterious recessive traits.

235. (B) Capital-intensive and vulnerable to failures like power loss or disease
Live ex situ conservation is capital-intensive and highly vulnerable to technical failures. Power outages can disrupt water filtration and aeration, while pathogens can spread rapidly in crowded tanks, causing catastrophic mortality. These risks make maintaining live gene banks challenging compared to more stable, cryogenic storage methods.

236. (A) Genetic integrity, fitness, and survival of fish post-release
Conservation aquaculture differs from commercial aquaculture by prioritizing genetic integrity, evolutionary fitness, and post-release survival over growth rates and biomass output. The goal is to produce wild-like fish capable of surviving, reproducing, and integrating into natural populations, rather than maximizing short-term harvest yields.

237. (A) Chitala chitala
The Clown Knifefish has been successfully bred in captivity in India to support restoration programs. Captive-bred fingerlings are restocked into rivers where populations have declined due to overfishing and habitat loss. This restocking helps restore the predatory niche of this native species in freshwater ecosystems.

238. (A) Registry of pedigrees and demographic history to inform breeding
Studbooks are central to managing ex situ breeding programs. They record the pedigree, birth date, sex, and transfer history of each captive individual. This demographic and genetic registry allows managers to design breeding pairs that minimize inbreeding and maximize genetic diversity, sustaining the long-term health of the captive population.

239. (A) Protect juveniles in captivity until they are less susceptible to predation
Headstarting is an ex situ conservation strategy where young organisms, such as sea turtles or fish fry, are reared in protective captivity during their most vulnerable early life stages. Once they grow large enough to be less susceptible to predators, they are released into the wild, increasing overall cohort survival.

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260. (B) Community-owned areas where locals protect habitat while retaining ownership
Under the Indian Wildlife Protection Act, Community Reserves are established on private or community-owned lands where local people voluntarily protect habitats and wildlife. This framework allows communities to conserve biodiversity while retaining their land tenure and resource rights, integrating traditional livelihoods with formal conservation goals.

261. (B) Facilitate local people in mapping resources and conservation planning
Participatory Rural Appraisal techniques are used in conservation to facilitate local communities in mapping natural resources, identifying threats, and planning management actions. This inclusive approach ensures that conservation projects incorporate local priorities, build community ownership, and utilize traditional knowledge to design more effective management strategies.

262. (A) Monitoring and iteratively adjusting strategies based on new data
Adaptive management in co-management regimes refers to the process of monitoring system outcomes and iteratively adjusting conservation strategies based on new biological and social data. This flexible approach allows managers to respond to environmental uncertainties, climate shifts, and socioeconomic changes, improving the effectiveness of conservation measures over time.

263. (A) The Pacific Islands (e.g., Fiji, Philippines)
Locally Managed Marine Areas have been widely and successfully established across the Pacific Islands, including Fiji and the Philippines. These initiatives empower coastal communities to manage their marine resources using traditional practices, such as temporary harvesting closures, combined with modern ecological monitoring to restore depleted fisheries.

264. (A) Unwritten rules dictating gear, closures, and access within the community
Customary laws are unwritten rules and social norms developed by communities to regulate resource use, such as restricting specific gear, declaring seasonal closures, or limiting access. Enforced through social pressure and traditional authority, these laws represent effective, self-regulating systems that promote sustainable fishing practices without government intervention.

265. (B) Obtaining information from a distance, typically via satellites
Remote Sensing in aquatic sciences involves gathering data about the Earth's oceans, lakes, and rivers from a distance, typically using sensors mounted on satellites, aircraft, or drones. This technology allows researchers to monitor physical and biological parameters across vast, inaccessible geographic areas continuously and cost-effectively.

266. (B) Visible light (specifically blue and green bands)
Optical sensors utilize the visible light spectrum, particularly the blue and green bands, to measure ocean color and chlorophyll-a concentrations. Phytoplankton absorb blue light for photosynthesis and reflect green light. Measuring the ratio of these reflected wavelengths allows researchers to estimate algal biomass from space.

267. (C) Active sensors emit energy and measure return; passive detect natural energy
Active remote sensors emit their own electromagnetic energy, such as radar or laser pulses, and measure the strength of the reflected signal. Passive sensors, conversely, rely on detecting natural radiation, such as reflected sunlight or thermal emissions, to gather information about the Earth's surface.

268. (A) Bathymetric LiDAR (Light Detection and Ranging)
Bathymetric LiDAR is an active sensor that uses green laser pulses to penetrate the water column and measure the distance to the seafloor. This technology is highly effective for mapping shallow coastal bathymetry, producing high-resolution three-dimensional models of benthic habitats from airborne platforms.

269. (B) Influenced by sediments, organic matter, and phytoplankton
The penetration depth of visible light in aquatic ecosystems is influenced by suspended sediments, dissolved organic matter, and phytoplankton concentrations. These substances absorb and scatter light, reducing water clarity and limiting the depth to which optical satellite sensors can detect benthic features or measure underwater parameters.

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ultra-low storage at minus one hundred ninety-six degrees Celsius, and programmable freezers ensure precise, controlled cooling rates.

251. (A) Arrests biological time, storing diversity with minimal space and cost
A major advantage of cryogenic gene banks is their ability to arrest biological time, preserving genetic diversity with minimal space and low maintenance costs. Unlike live gene banks, which require continuous water filtration, feeding, and disease management, cryopreserved samples can be stored indefinitely in liquid nitrogen, insulated from catastrophic facility failures.

252. (C) Resurrecting extinct species from frozen diploid somatic cell lines
Somatic Cell Nuclear Transfer represents a theoretical pathway for resurrecting extinct or critically endangered fish species. By transferring the nucleus of a preserved diploid somatic cell into an enucleated egg of a closely related species, researchers could generate cloned offspring, preserving genetic lineages that would otherwise be lost.

253. (C) Involving local communities and ensuring they receive socio-economic benefits
Community-based conservation is built on the premise that effective biodiversity protection requires involving local communities and ensuring they receive tangible socio-economic benefits. When local people hold a stake in resource management, they are more likely to support conservation goals, leading to sustainable harvesting and reduced poaching.

254. (A) Sharing power and decision-making between government and local users
Co-management in fisheries involves sharing power, responsibility, and decision-making authority between government agencies and local resource users. This collaborative approach combines state regulatory oversight with local knowledge and monitoring, fostering cooperative enforcement, reducing conflicts, and promoting more sustainable, community-backed fisheries management practices.

255. (A) Derived from empirical observations and intimate interaction with environment
Traditional Ecological Knowledge is distinct from formal scientific knowledge because it is derived from generations of empirical observations and intimate, hands-on interaction with the local environment. Passed down orally within communities, it provides context-specific insights into species behavior, seasonal migration patterns, and historical ecological baselines.

256. (B) The protection of sacred pools (Temple Sanctuaries) where fishing is strictly taboo
The protection of sacred pools or temple sanctuaries in the Western Ghats is a classic example of community-based conservation. Enforced by local religious beliefs and cultural taboos, these areas function as effective freshwater reserves where fishing is prohibited, protecting mature fish and preserving aquatic biodiversity.

257. (A) Baselines of abundance, spawning grounds, and migration cues
Integrating Traditional Ecological Knowledge with scientific management is valuable for identifying baseline population abundances, critical spawning grounds, and environmental migration cues. This integration combines scientific monitoring with local observations, helping managers design spatial closures and sustainable catch limits that align with the natural cycles of the fishery.

258. (B) Assigning exclusive access rights to local communities to incentivize management
Territorial Use Rights in Fisheries promote conservation by assigning exclusive fishing access rights to specific local communities or cooperatives. This secure tenure incentivizes fishers to manage resources sustainably, as they directly benefit from the long-term recovery and productivity of their local marine or freshwater habitats.

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259. (A) Lack of trust, unequal power, and conflicting objectives between parties
A major challenge in implementing co-management is the lack of trust, unequal power dynamics, and conflicting objectives between government authorities and local fishers. Overcoming these barriers requires transparent communication, shared decision-making, and the equitable distribution of resources to build a collaborative, long-term conservation partnership.

240. (D) A is false but R is true.
Ex situ conservation is not a substitute for in situ conservation, nor can captive environments replicate the complex ecological interactions and natural selection pressures found in the wild. Therefore, the assertion is false, as ex situ measures serve only as a temporary safety net to support broader in situ habitat restoration.

241. (B) -196°C
Cryopreservation involves freezing and storing biological materials at ultra-low temperatures. This is typically achieved using liquid nitrogen, which maintains a stable storage temperature of minus one hundred ninety-six degrees Celsius. At this temperature, all metabolic processes and chemical reactions in the cells are completely arrested, preserving them indefinitely.

242. (A) Size, yolk volume, and chilling sensitivity inhibit cryoprotectant penetration
Cryopreserving fish eggs and embryos is difficult due to their large size, high yolk volume, and chilling sensitivity. These traits, along with a thick, outer chorion layer, prevent cryoprotectants from penetrating the cell uniformly. Consequently, ice crystals form internally during freezing, causing cellular damage and preventing successful recovery.

243. (A) Fish milt and primordial germ cells (PGCs)
Because fish embryos cannot currently be successfully cryopreserved, researchers focus on storing fish milt and primordial germ cells. Milt is relatively easy to freeze, while primordial germ cells can be harvested from donor embryos, frozen, and later transplanted into host embryos to produce fertile gametes of the target species.

244. (B) Lower freezing point and reduce intracellular ice crystal formation
Cryoprotectants, such as dimethyl sulfoxide and glycerol, are essential for preserving cells at ultra-low temperatures. They lower the freezing point of the solution and reduce intracellular ice crystal formation during freezing. This action prevents physical damage to cellular membranes and organelles, ensuring cell viability upon thawing.

245. (D) Transplanting PGCs into a surrogate host which then produces donor gametes
Recovering live, fertile fish from cryopreserved primordial germ cells requires transplanting these cells into a sterile surrogate host of a closely related species. As the host matures, the transplanted cells migrate to its gonads, allowing it to produce functional gametes that carry the genetic profile of the donor species.

246. (A) Cell lines for virological studies and future cloning
Tissue culture techniques, such as growing fin explants, are used in aquatic conservation to establish continuous cell lines. These cell lines support virological research, disease diagnostic testing, and toxicological assays. They also preserve the diploid genome of threatened species, serving as a resource for genetic research and potential cloning.

247. (A) Initiate sperm motility via changes in osmolality or specific ions
During the thawing of cryopreserved fish milt, adding an activating solution is necessary to initiate sperm motility. In many fish, sperm are quiescent in the seminal plasma and only become motile when exposed to changes in osmolality or ion concentration in the surrounding water, enabling successful fertilization.

248. (A) Convert solutions into glass-like solid without forming ice crystals
Vitrification is an advanced cryopreservation technique that solidifies liquids into a glass-like state without forming ice crystals. This is achieved by using high concentrations of cryoprotectants and ultra-rapid cooling rates. Avoiding ice crystallization protects delicate cellular structures, making vitrification a promising method for preserving complex tissues.

249. (C) Rainbow Trout / Masu Salmon
Surrogate broodstock technology has been used to propagate species within the family Salmonidae, such as transferring primordial germ cells between rainbow trout and masu salmon. This technique allows a sterile host of one species to produce fertile gametes of another, providing a novel way to recover endangered fish using common surrogate species.

250. (A) P-3, Q-1, R-2, S-4
These matches align cryopreservation components with their functions. Extender solutions maintain osmotic balance to prevent premature sperm activation, while DMSO acts as an intracellular cryoprotectant. Liquid nitrogen provides stable,

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270. (D) Penetrate clouds and operate without solar light to detect surface features
Synthetic Aperture Radar is an active microwave technology that can penetrate cloud cover and operate without solar illumination. This capability makes SAR highly valuable for oceanographic monitoring, as it can detect surface roughness, sea ice, oil spills, and ship traffic regardless of weather conditions or time of day.

271. (A) Thermal infrared
Measuring Sea Surface Temperature from space relies on monitoring thermal infrared radiation emitted by the ocean's surface skin. Satellite radiometers detect this longwave radiation, which is then converted into temperature estimates. This data is essential for tracking ocean currents, thermal fronts, and marine heatwaves.

272. (A) Chlorophyll-a concentration, indicating phytoplankton biomass
Ocean color measurements serve as a proxy for chlorophyll-a concentration, which directly reflects phytoplankton biomass in the upper water column. Tracking these color shifts allows scientists to monitor primary productivity, map ocean currents, detect algal blooms, and assess the overall health of marine food webs from space.

273. (A) Landsat
The Landsat satellite series has provided continuous, high-resolution multispectral imagery of the Earth's surface for several decades. This long-term dataset is highly valued by researchers for mapping coastal ecosystems, monitoring mangrove extent, tracking wetland change, and assessing the impacts of land-use changes on watersheds.

274. (B) Size of the smallest discernible feature represented by a pixel
Spatial resolution defines the size of the smallest geographical feature that can be resolved by a satellite sensor and represented by a single pixel. High-spatial-resolution imagery provides detailed views of small features, such as individual coral heads, while low-resolution imagery is suited for mapping regional oceanographic patterns.

275. (A) Field measurements at satellite locations to validate remote data
Ground truthing involves collecting physical field measurements, such as water temperature, clarity, or species composition, at the exact coordinates of satellite observations. This on-site data is used to calibrate satellite sensors, validate remote sensing models, and assess the accuracy of generated habitat maps.

276. (B) Water absorbs and scatters radiation, attenuating light beyond a depth
Mapping underwater benthic habitats using optical satellite imagery is restricted to shallow zones because water absorbs and scatters electromagnetic radiation. This attenuation rapidly reduces light penetration with depth, preventing optical sensors from receiving reflected signals from the seafloor in deeper oceanic waters.

NODIA

277. (A) Integrates spatial data with attributes, allowing for complex analysis
Geographic Information Systems are distinct from simple digital maps because they integrate spatial data with detailed attribute tables. This link allows researchers to perform complex spatial analyses, query database features, model environmental suitability, and visualize relationships between ecological variables and geographic coordinates.

278. (B) Vector data model
The vector data model represents discrete geographic features using coordinate geometry. Points mark specific locations like spawning sites, lines trace linear features like rivers, and polygons outline bounded areas like marine protected zones. This structure is highly efficient for representing precise boundaries and topological relationships.

279. (A) Raster data model (a grid of cells/pixels)
Continuous spatial phenomena, such as temperature, elevation, or chlorophyll gradients, are best represented in GIS using the raster data model. This structure consists of a grid of equally sized cells or pixels, where each cell contains a value representing the measured environmental variable at that specific location.

280. (B) Estimate values at unsampled locations based on scattered points
Spatial interpolation is a GIS process used to estimate environmental values at unsampled locations based on a set of scattered sample points. This technique is commonly used to generate continuous maps, such as water quality or salinity surfaces, from localized water sampling stations.

281. (C) Spatial interpolation techniques
Inverse Distance Weighting and Kriging are classic spatial interpolation techniques. IDW estimates values based on the distance to nearby sample points, assuming closer points are more similar. Kriging is a geostatistical method that incorporates spatial autocorrelation to produce statistically optimal, continuous surface predictions.

282. (D) Map algebra / Raster overlay
Habitat suitability modeling often combines multiple environmental raster layers, such as depth, temperature, and substrate type, using mathematical formulas. In GIS, this process is known as map algebra or raster overlay. It allows analysts to calculate cumulative suitability scores across landscapes, identifying priority zones for species conservation.

283. (A) Buffer
To define a specific exclusion zone around a geographic feature, such as a five-kilometer area surrounding a coral reef polygon, a GIS analyst should use the buffer tool. This geprocessing function creates a new polygon at a specified distance around the input feature, defining the boundary of the protected zone.

284. (A) Transform Earth's 3D surface onto a 2D flat plane
A map projection is mathematically required to transform the Earth's three-dimensional ellipsoidal surface onto a two-dimensional flat plane. This process always introduces some distortion in shape, area, distance, or direction, which analysts must manage to ensure accurate spatial measurements in GIS databases.

285. (A) Predicting range expansion and identifying vulnerable habitats
GIS is highly valuable for mitigating biological invasions by predicting the potential range expansion of invasive species. By overlaying environmental parameters with species tolerance data, analysts can map areas highly vulnerable to invasion, allowing resource managers to direct monitoring and preventative measures to high-risk zones.

286. (A) A 3D representation of terrain surface; Digital Bathymetric Model (DBM)
A Digital Elevation Model is a three-dimensional raster representation of a terrain's surface. Its aquatic equivalent is a Digital Bathymetric Model, which represents the topography of the seafloor or lake bed below the water surface, serving as a foundational layer for modeling hydrodynamic flows and benthic habitats.

287. (D) Tabular info like pH, oxygen, and date associated with a station
Attribute data in a GIS database consists of tabular information associated with spatial features. In an aquatic study, this includes non-spatial data, such as dissolved oxygen levels, pH measurements, collection dates, and species counts recorded at a specific water sampling coordinate.

288. (D) Represents precise geometric boundaries and network topology
An advantage of vector data over raster data is its ability to represent precise geometric boundaries and network topology. This precision is essential for mapping legal boundaries, such as those of marine reserves, and modeling linear pathways, like river networks, where connectivity dictates ecological flows.

289. (B) Guide fishermen to areas where fish are likely to aggregate
Potential Fishing Zone advisories, generated by the Indian National Centre for Ocean Information Services, integrate remote sensing data to guide fishers to areas where pelagic fish are likely to aggregate. This service reduces search time and fuel consumption, improving the economic efficiency of coastal fishing operations.

290. (B) Sea Surface Temperature (SST) and Chlorophyll-a concentration
Potential Fishing Zone advisories are generated by superimposing satellite-derived Sea Surface Temperature and Chlorophyll-a data. SST maps identify thermal fronts and eddies, while chlorophyll-a maps indicate phytoplankton concentration. Overlaying these parameters

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reveals productive ocean zones where pelagic fish are highly likely to aggregate.

291. (A) Indicate upwelling and productivity, which attracts shoaling fish
Zones where Sea Surface Temperature gradients, or thermal fronts, coincide with high Chlorophyll-a concentrations indicate active upwelling and high primary productivity. These conditions attract zooplankton and baitfish, which in turn attract larger, commercially valuable shoaling pelagic fishes, creating highly productive potential fishing grounds.

292. (A) Cold, nutrient-rich deep waters rising, fueling phytoplankton blooms
Upwelling zones are oceanographic features characterized by the rising of cold, nutrient-rich deep waters to the sunlit surface. This nutrient influx fuels rapid phytoplankton growth, triggering massive primary productivity. These highly productive zones are critical habitats that support dense concentrations of marine life and valuable commercial fisheries.

293. (D) Boolean logic / Multi-criteria overlay analysis
Demarcating Potential Fishing Zones in a GIS environment relies on combining temperature and chlorophyll raster layers. Analysts use Boolean logic or multi-criteria overlay analysis to identify areas that meet both thermal front and high chlorophyll-a thresholds, outlining the geographic boundaries of the potential fishing zones.

294. (A) May lead to overexploitation if used by massive industrial fleets
While Potential Fishing Zone advisories improve fishing efficiency, their unregulated use by large industrial fleets raises conservation concerns. Directing intensive fishing pressure to biological aggregation zones can accelerate the depletion of pelagic fish stocks, demanding careful integration with sustainable catch limits and seasonal closures.

295. (A) Oceansat (e.g., OCM payload)
The Indian Oceansat satellite series, carrying the Ocean Colour Monitor payload, is a vital asset for gathering real-time data used in Potential Fishing Zone advisories. This sensor measures spectral reflectance to estimate chlorophyll-a concentrations, providing high-resolution ocean color data for fishery management.

296. (B) The extent, movement, and duration of Harmful Algal Blooms
Integrating Sea Surface Temperature and chlorophyll-a data is also used to monitor the extent, movement, and duration of Harmful Algal Blooms. These toxic blooms threaten coastal aquaculture and public health, and remote sensing provides an early warning system that allows managers to mitigate ecological and economic impacts.

297. (A) Geometric size of a pixel representing a square area of ocean
In spatial ecology, the ground resolution cell refers to the physical geometric size of a single pixel on the ground. For a satellite chlorophyll-a map, a resolution of one kilometer means each pixel integrates the environmental reflectance across a one-square-kilometer area of the ocean's surface.

298. (D) Georeferencing to ensure they align to the same coordinate system
To accurately overlay Sea Surface Temperature and Chlorophyll-a imagery in GIS, both datasets must undergo georeferencing. This process assigns geographic coordinates to the pixels of each image, ensuring that they align precisely to the same spatial coordinate system for accurate overlay analysis.

299. (B) A circular or spiral-shaped anomaly in surface temperature
On Sea Surface Temperature imagery, a mesoscale eddy is indicated by a circular or spiral-shaped thermal anomaly. These rotating water masses can upwell nutrients or trap warm surface water, concentrating plankton and attracting marine predators like tuna, making them highly important oceanographic features for spatial fisheries modeling.

300. (C) Framework to monitor changes, map habitats, and design protected areas
The ultimate utility of integrating Remote Sensing and Geographic Information Systems in conservation is that it provides a powerful spatial framework to monitor ecological changes, map critical habitats, and design effective protected area networks, supporting sustainable resource management across marine and freshwater ecosystems.

NODIA

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(A) Allow embryos to develop on the parent to avoid initial osmotic stress
(B) Prevent seeds from germinating in high salinity environments by keeping them dormant
(C) Disperse seeds exclusively via wind currents to inland freshwater lakes
(D) Attract specific marine fish for seed pollination

2016

48. Coral reefs located off the coast of the Andaman and Nicobar Islands are predominantly classified as:
(A) Atolls
(B) Barrier reefs
(C) Fringing reefs
(D) Patch reefs exclusively

2021

49. Biogenic calcification in hermatypic corals involves the precipitation of calcium carbonate in which specific mineral form?
(A) Aragonite
(B) Dolomite
(C) Magnesite
(D) Aragonite

2009

50. What makes seagrass beds critical nursery habitats for many commercially important marine species?
(A) Leaf canopies provide refuge and support abundant epibenthic food sources
(B) They possess toxic leaves that kill predators instantly
(C) They grow exclusively in hypersaline pools where pelagic predators cannot survive
(D) They emit sound waves that deter larger piscivorous fish

2010

51. The structural complexity of epifaunal communities on mudflats is often lower than in rocky intertidal zones primarily because:
(A) The lack of stable, hard attachment surfaces limits the settlement of sessile organisms
(B) Mudflats completely dry out during high tide
(C) Excessive dissolved oxygen in mudflats is toxic to epifauna
(D) Wading birds consume all epifauna before they can settle

2011

52. Which halophyte is universally recognized as a pioneer species in salt marsh ecological succession, actively stabilizing bare mudflats?
(A) Typha angustifolia
(B) Nelumbo nucifera
(C) Salicornia europaea
(D) Nymphaea alba

2014

53. Hydrophytes in freshwater wetlands exhibit specific anatomical adaptations. The presence of aerenchyma tissue serves which vital function?
(A) Transporting oxygen to submerged roots in anaerobic soil environments
(B) Providing structural rigidity against strong oceanic waves
(C) Storing large quantities of salt for osmoregulation
(D) Producing toxic secondary metabolites to deter herbivory

2017

54. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): Temperature-dependent sex determination (TSD) makes marine turtle populations highly vulnerable to global warming.
Reason (R): Rising incubation temperatures above the pivotal temperature drastically skew the sex ratio, producing exclusively female populations and threatening reproductive viability.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2018

55. The LAL (Limulus Amebocyte Lysate) test, critical in modern biomedicine, relies on the hemolymph of horseshoe crabs. What is the precise biological reaction exploited by this test?
(A) Amebocytes in the hemolymph rapidly coagulate in the presence of Gram-negative bacterial endotoxins
(B) The hemolymph produces antibodies against human viruses
(C) The hemolymph completely dissolves bacterial cell walls on contact
(D) Hemocyanin binds specifically to heavy

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(D) Hermatypic corals host zooxanthellae for reef-building; ahermatypic corals lack them.

2012

7. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): Seagrass beds are globally recognized as significant sinks for "blue carbon".
Reason (R): Seagrasses sequester carbon dioxide efficiently and store organic carbon in their extensive root and rhizome systems and underlying sediments for millennia.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2012

8. Psammophytic plants inhabiting coastal sand dune are morphologically adapted to survive which set of primary environmental stressors?
(A) Sub-zero temperatures, permafrost, extreme shading, and constant high-altitude winds
(B) Continuous freshwater inundation, high clay content, severe hypoxia, and waterlogging
(C) High substrate instability, salt spray, low nutrient availability, and desiccation
(D) Extreme hydrostatic pressure, complete darkness, high dissolved silica, and cold currents

2008

9. In salt marsh ecosystems, halophytes maintain cellular turgor and prevent desiccation in hypersaline soils primarily through which physiological mechanism?
(A) Active transport of water out of the root cells into the surrounding soil profile
(B) Complete cessation of transpiration during all daylight hours to prevent water loss
(C) Synthesis of complex starch molecules to increase extracellular osmotic potential levels
(D) Accumulation of compatible solutes like proline and glycine betaine in the cytoplasm

2013

10. According to the Ramsar Convention classification, which of the following best describes the hydrology and soil characteristics of a typical freshwater wetland?
(A) Shallow freshwater inundation leading to the formation of anaerobic hydric soils
(B) High salinity surface water flows interacting with well-drained, oxygenated sands
(C) Permanent deep-water oceanic conditions characterized by calcareous rocky substrates
(D) Seasonal hypersaline conditions resulting in the deposit of thick evaporite minerals

2002

11. The phenomenon of "arribada" is specifically associated with the mass synchronous nesting ecology of which of the following marine species?
(A) Eretmochelys imbricata
(B) Lepidochelys olivacea
(C) Dermochelys coriacea
(D) Chelonia mydas

2014

12. The Indian horseshoe crab species Tachypleus gigas and Carcinoscorpius rotundicauda possess significant biomedical value primarily due to which unique characteristic?
(A) Their exoskeleton is a primary source for processing medical-grade chitin products
(B) Their hemolymph yields amebocytes used to detect bacterial endotoxins via LAL tests
(C) Their liver extracts are synthesized into treatments for heavy metal poisoning cases
(D) Their reproductive organs contain catalysts that actively reverse ocean acidification

2003

13. Which of the following anthropogenic activities directly causes "coastal squeeze" in Ecologically Sensitive Areas?
(A) Construction of hard defenses preventing landward habitat migration during sea-level rise
(B) Selective harvesting of pelagic species using traditional and artisanal catching methods
(C) Implementation of strict catch-and-release protocols for all recreational fishing activities
(D) Establishment of expansive no-take zones within strictly managed marine protected areas

2004

14. Which physiological mechanism primarily triggers mass coral bleaching events associated with global climate change?
(A) Rapid increases in oceanic calcium carbonate saturation states within the water
(B) Enhanced upwelling of cold waters leading to extreme zooxanthellae overpopulation

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CHAPTER 08
Management of Ecologically Sensitive Areas

2008

1. Which of the following best defines the primary ecological objective of declaring an area as an Eco-Sensitive Zone (ESZ) around a protected area in India?
(A) To completely prohibit all human settlements and agricultural activities within a 10 km radius of the protected area
(B) To create a transition zone that minimizes the impact of human activities on the fragile ecosystem of the protected area
(C) To facilitate large-scale ecotourism infrastructure development immediately adjacent to the core protected area
(D) To establish a new core breeding habitat for apex predators displaced from the primary protected area

2021

2. The edge effect in a transitional aquatic ecosystem typically results in which of the following ecological phenomena?
(A) A decrease in overall species richness compared to the adjacent distinct ecosystems
(B) An exclusive dominance of climax community species with low reproductive rates
(C) A uniform distribution of nutrients and energy flow identical to the adjacent open water ecosystem
(D) An increased species diversity and density due to the overlapping of adjacent community boundaries

2012

3. In the context of mangrove taxonomy, which characteristic reliably distinguishes true mangroves from mangrove associates?
(A) True mangroves possess specialized morphological and physiological adaptations to the intertidal environment, whereas associates do not exclusively rely on this habitat
(B) Mangrove associates are exclusively found in the intertidal zone, whereas true mangroves occur inland
(C) True mangroves reproduce strictly via spores, while mangrove associates reproduce using seeds
(D) Mangrove associates exhibit vivipary and pneumatophores, while true mangroves lack these structures

2008

4. Which of the following plant genera exhibits vivipary and possesses pneumatophores as primary adaptations to its saline, anaerobic habitat?
(A) Ipomoea
(B) Rhizophora
(C) Avicennia
(D) Spinifex

2004

5. Fringing reefs, barrier reefs, and atolls represent the three major geomorphological classifications of coral reefs. Which of the following statements accurately characterizes an atoll?
(A) A ring-shaped reef system encircling a lagoon without a central landmass
(B) A linear reef structure separated from a mainland by a deep, wide lagoon
(C) A coastal reef that grows directly out from the shoreline without a lagoon
(D) A submerged reef formation found exclusively in freshwater river deltas

2008

6. What is the primary ecological difference between hermatypic and ahermatypic corals?
(A) Hermatypic corals inhabit deep aphotic zones, while ahermatypic corals prefer shallow photic areas.
(B) Hermatypic corals produce siliceous skeletons; ahermatypic corals utilize calcium carbonate bases.
(C) Hermatypic corals remain solitary individuals, whereas ahermatypic corals form massive colonies.

NODIA

notify an area as an Ecologically Sensitive Area (ESA)?
(A) High density of urban infrastructure and commercial shipping routes
(B) Endemism, richness, unique geomorphology, and vulnerability to human threats
(C) Potential for high-yield mechanized agriculture and extensive groundwater extraction
(D) Complete absence of flora and fauna suitable for industrial estate establishment

2009
24. What is the fundamental role of "blue carbon" sequestration in estuarine ecotones?
(A) The release of carbon monoxide from anaerobic bacterial respiration
(B) The process of turning ocean water blue through carbon dissolution
(C) Capture and storage of atmospheric carbon by mangroves and seagrasses
(D) The rapid mineralization and immediate atmospheric release of carbon

2023
25. Consider the following statements regarding the global distribution and tidal zonation of mangroves:
I. Mangroves are predominantly found in tropical and subtropical latitudes.
II. True mangroves are highly intolerant of any variation in soil salinity.
III. Rhizophora typically occupies the lower intertidal zone due to its robust stilt roots.
IV. Mangroves achieve maximum canopy height in hyper-arid coastal deserts.
V. Avicennia is often found in the mid-to-high intertidal zones equipped with pneumatophores.
Which of the above statements are correct?
(A) I, III, and V
(B) II, III, and IV
(C) I, II, and V
(D) III, IV, and V

2010
26. In true mangrove species, the physiological process of "salt exclusion" primarily takes place at which structural interface?
(A) The root endodermis via ultrafiltration
(B) The stomatal guard cells
(C) The salt glands on the leaf surface
(D) The pneumatophore lenticels

2023
27. The occurrence of hermatypic coral reefs is strictly constrained globally by specific oceanographic parameters. Which of the following conditions is optimal for their extensive growth?
(A) High turbidity, cold water, and soft muddy substrates
(B) Clear, warm water, shallow depth, and stable salinity
(C) Lack of sunlight, low oxygen, and estuarine mixing
(D) Suspended particulate matter and freshwater runoff

2008
28. Which of the following statements incorrectly describes the zooxanthellae symbiosis in corals?
(A) Zooxanthellae are dinoflagellates residing within the endodermal cells of the coral host
(B) The coral host receives fixed nitrogen while providing a calcium skeleton for algae to eat
(C) The symbiotic algae provide the coral with translocated photosynthates, enhancing calcification
(D) The coral provides the zooxanthellae with metabolic waste products like carbon dioxide

2018
29. Seagrasses are unique among marine macrophytes because they are:
(A) True angiosperms that possess roots, rhizomes, and leaves, and can reproduce via submerged pollination
(B) Macroalgae completely lacking a vascular system
(C) Bryophytes adapted to deep ocean trenches
(D) Gymnosperms that rely on wind for underwater pollination

2017
30. Which characteristic makes mudflats highly productive habitats for wading birds despite the seemingly barren surface?
(A) High density of large fruiting trees providing canopy shelter
(B) The presence of expansive terrestrial grassland vegetation
(C) Infaunal invertebrate biomass supported by detrital food webs
(D) The occurrence of hard coral aggregations immediately below the surface

2019
31. Spartina species in salt marsh ecosystems typically exhibit vertical zonation patterns.

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What is the most relevant factor determining their lower elevation limit in the intertidal zone?
(A) Intense competition with diverse upland terrestrial vegetation species
(B) Inability to survive sudden freezing temperatures during a winter low tide
(C) Absolute requirement for freshwater to complete the annual reproductive cycle
(D) Tolerance to prolonged flooding, tidal energy, and associated soil anoxia

2009
32. Hydric soils in freshwater wetlands are fundamentally characterized by:
(A) High oxidation-reduction potential promoting rapid aerobic decomposition
(B) Extreme aridity causing the soil to crack and form polygonal structures
(C) Saturation creating anaerobic conditions and organic matter accumulation
(D) Constant mixing by river currents preventing any sediment deposition

2023
33. The sex ratio of sea turtle hatchlings is determined by Temperature-Dependent Sex Determination (TSD). What is the specific effect of incubation temperature in these reptiles?
(A) Higher incubation temperatures generally produce a higher proportion of male hatchlings
(B) Higher incubation temperatures generally produce a higher proportion of female hatchlings
(C) Temperature only determines the size of the hatchlings, not their sex
(D) Lower temperatures induce genetic mutations that reverse sex chromosomes

2015
34. Which anthropogenic threat involves physically scraping the ocean floor, causing severe mechanical destruction to benthic habitats such as seagrass beds and coral reefs?
(A) Longline fishing
(B) Surface purse seining
(C) Artisanal handline fishing
(D) Bottom trawling and dredging

2018
35. Consider the following statements regarding the impacts of ocean acidification on coastal Ecological Sensitive Areas:
I. Decreases the concentration of carbonate ions available in seawater.
II. Enhances the biogenic calcification rates of hermatypic corals.
III. Lowers the pH of the ocean water.
IV. Weakens the structural integrity of existing coral reef frameworks.
V. Specifically promotes the explosive growth of all calcareous macroalgae.
Which of the above statements are incorrect?
(A) II and V
(B) I and III
(C) III and IV
(D) I and IV

2022
36. Which Indian coastal National Park is globally renowned as the world's largest mass nesting site for Olive Ridley turtles?
(A) Mahatma Gandhi Marine National Park
(B) Gulf of Mannar Marine National Park
(C) Gahirmatha Marine Sanctuary
(D) Malvan Marine Sanctuary

NODIA

2004
37. The buffer zone of a Biosphere Reserve serves primarily to:
(A) Host activities compatible with sound ecological practices
(B) Provide a space for unrestricted heavy industrial development
(C) Completely isolate the core area from any scientific research or monitoring
(D) Serve as the primary area for commercial clear-cutting of timber

2016
38. According to the CRZ notifications, how is the High Tide Line (HTL) technically defined for regulatory mapping?
(A) The line where the sea depth drops below 10 meters at low tide
(B) The maximum extent of storm surge observed in the last decade
(C) The boundary situated exactly 500 meters landward from the low mark
(D) The line reached by the highest astronomical tide using physical markers

2014
39. Which of the following activities is expressly prohibited under the Wetland (Conservation and Management) Rules in India?
(A) Regulated harvesting of specific fish species by local communities
(B) Solid waste dumping and discharge of untreated industrial effluents into the

wetland
(C) Scientific monitoring of migratory bird populations
(D) Removal of invasive weed species for ecological restoration

2022
40. The inclusion of horseshoe crabs in Schedule IV of the Wildlife (Protection) Act, 1972 mandates that:
(A) They can be freely harvested for commercial fertilizer production without permits
(B) Their hunting and trade are strictly regulated, requiring specific permissions from the Chief Wildlife Warden
(C) They are designated as vermin and can be culled freely
(D) Only their eggs are legally protected, while adults can be harvested

2004
41. The Convention on Biological Diversity (CBD) identifies three primary goals. Which of the following is NOT one of these core goals?
(A) The conservation of biological diversity
(B) The sustainable use of the components of biological diversity
(C) The fair and equitable sharing of the benefits arising out of the utilization of genetic resources
(D) The complete privatization of all marine genetic resources

2012
42. In coral transplantation protocols aimed at ecological restoration, what is the concept of "coral gardening"?
(A) Growing fragments in nurseries for later outplanting to degraded sites
(B) Planting terrestrial flowering plants directly onto reefs during low tide
(C) Using heavy machinery to carve garden-like patterns into the framework
(D) Introducing exotic, fast-growing macroalgae to outcompete native corals

2005
43. An effective Integrated Coastal Zone Management (ICZM) plan requires multi-stakeholder spatial planning. Which action represents a failure of this principle?
(A) Mapping overlapping zones of artisanal fishing and offshore wind energy development
(B) Prioritizing tourism developers over fishing communities without consultation
(C) Establishing a cross-sectoral committee to review coastal infrastructure proposals
(D) Integrating climate change vulnerability assessments into municipal coastal planning

2016
44. What distinguishes an Eco-Sensitive Zone (ESZ) from a National Park in the context of Indian environmental law?
(A) An ESZ completely bans human entry; a National Park allows free public access for extraction
(B) An ESZ acts as a regulatory buffer; a National Park strictly prohibits unauthorized exploitation
(C) An ESZ is a marine designation; National Parks are exclusively for terrestrial forest ecosystems
(D) An ESZ is governed by international law; National Parks are governed by local village councils

2005
45. In transitional aquatic ecosystems like estuaries, how does the process of nutrient cycling differ from that in open ocean ecosystems?
(A) Mixing and riverine input drive localized nutrient retention and high cycling
(B) Nutrients are permanently lost to the deep sea without any recycling
(C) Nutrient cycling is exclusively driven by chemosynthetic bacteria in the photic zone
(D) Nitrogen fixation is completely suppressed due to the constant influx of freshwater

2010
46. Consider the following statements regarding the taxonomy and distribution of mangroves:
I. Sundarbans represents the largest contiguous mangrove forest in the world.
II. Mangrove associate species possess extensive pneumatophore networks.
III. Sonneratia and Bruguiera are classified as true mangrove genera.
IV. India accounts for more than 50% of the world's total mangrove cover.
Which of the above statements are correct?
(A) I and III
(B) I and II
(C) III and IV
(D) II and IV

2012
47. The physiological adaptation of vivipary in true mangroves serves to:

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2004

64. Artificial reef deployment is a common ecological restoration technique. What is its primary ecological function in a degraded coastal habitat?
(A) Structural complexity facilitating benthic settlement and attracting fish
(B) To immediately eradicate all invasive species from the area
(C) To act as a chemical sponge that absorbs heavy metal pollutants from the water column
(D) To physically block all ocean currents entering an estuary

2014

65. The success of an Integrated Coastal Zone Management (ICZM) program is predominantly measured by its ability to:
(A) Completely halt all economic activities along the coastline
(B) Balance conservation with sustainable development via participatory governance
(C) Transfer all coastal land ownership to private international corporations
(D) Relocate all coastal populations to inland metropolitan areas

2003

66. Consider the following criteria used to designate an area as an Eco-Sensitive Zone (ESZ):
I. High degree of endemism.
II. Proximity to dense urban centers without biodiversity value.
III. Serving as a crucial wildlife corridor.
IV. High potential for large-scale mining operations.
V. Presence of geomorphological features of unique value.
Which of the above criteria are correct?
(A) I, III, and V
(B) II, III, and IV
(C) I, II, and IV
(D) III, IV, and V

2009

67. Blue carbon sequestration in estuarine ecotones is highly efficient because:
(A) Anaerobic conditions in sediments slow the decomposition of organic matter
(B) High oxygen levels in sediments accelerate organic matter breakdown
(C) Tidal currents continuously export all organic carbon directly to the atmosphere
(D) Carbon dioxide is chemically transformed into solid diamond crystals over decades

2016

68. The pneumatophores of Avicennia species possess which specific anatomical structures that allow for gas exchange during low tide?
(A) Hydathodes
(B) Lenticels
(C) Trichomes
(D) Stomata on the roots

2003

69. Which of the following best describes the osmoregulatory strategy of the true mangrove, Rhizophora?
(A) Ultrafiltration in root membranes prevents salt entry via exclusion
(B) It actively excretes large volumes of salt through specialized salt glands on its leaves
(C) It has no osmoregulatory mechanism and relies entirely on frequent rainfall to flush salt from its tissues
(D) It stores all absorbed salt indefinitely within its reproductive propagules

NODIA

2006

70. Which specific geomorphological type of coral reef forms a barrier enclosing a deep lagoon, but lacks a central island?
(A) Fringing reef
(B) Patch reef
(C) Barrier reef
(D) Atoll

2001

71. The symbiotic relationship between hermatypic corals and zooxanthellae is best described ecologically as:
(A) Commensalism
(B) Parasitism
(C) Mutualism
(D) Amensalism

2013

72. Which physiological mechanism allows seagrasses to survive completely submerged in the marine environment?
(A) Extensive aerenchyma tissue facilitating internal gas transport to roots
(B) They lack stomata entirely and absorb all gases through a highly cutinized epidermis
(C) They utilize strictly anaerobic respiration for all metabolic energy needs
(D) They extrude their root systems out of the sediment to access dissolved oxygen in the water column

metals in contaminated vaccines

2001

56. Coastal eutrophication, primarily driven by agricultural runoff, typically results in which cascading ecological impact?
(A) Increased depth of the photic zone leading to significantly deeper coral growth profiles
(B) Sudden increase in seagrass meadow expansion due to surplus nitrogen in the water column
(C) Immediate precipitation of dissolved silicates forming brand new reef framework structures
(D) Macroalgal proliferation and subsequent decomposition leading to hypoxic dead zone formation

2006

57. Which mechanism accurately describes how sea-level rise fundamentally alters coastal Ecologically Sensitive Areas?
(A) It decreases the hydrostatic pressure on benthic communities, allowing deep-sea organisms to invade intertidal zones
(B) It induces shoreline erosion, saltwater intrusion, and prolonged flora inundation
(C) It causes the immediate tectonic uplift of fringing coral reefs
(D) It uniformly increases the salinity of the entire global ocean surface layer

2022

58. Site selection criteria for establishing an effective Marine Protected Area (MPA) network should strongly prioritize which of the following ecological principles?
(A) Selection of highly degraded, species-poor sites to encourage artificial seeding
(B) Habitat diversity, life-cycle connectivity, and adequate spatial sizing
(C) Proximity exclusively to major commercial shipping lanes to monitor vessel traffic
(D) Ensuring the selected site is completely devoid of any endemic species

2009

59. The Gulf of Mannar Biosphere Reserve is particularly noted for the conservation of which endangered marine mammal associated with seagrass ecosystems?
(A) Blue Whale
(B) Sperm Whale
(C) Dugong
(D) Ganges River Dolphin

2005

60. Which of the following statements is incorrect concerning the categorization under the Coastal Regulation Zone (CRZ) rules?
(A) CRZ-I includes ecologically sensitive areas like mangroves and coral reefs where development is heavily restricted.
(B) CRZ-II includes areas that have already been developed up to or close to the shoreline within designated municipal limits.
(C) CRZ-III areas are relatively undisturbed rural coastlines where specific developmental activities are allowed.
(D) CRZ-IV encompasses the water areas from the Low Tide Line to 12 nautical miles seaward.

2006

61. Under the institutional mechanisms of the Wetland (Conservation and Management) Rules, which body holds the primary responsibility for notifying wetlands at the state level in India?
(A) The National Green Tribunal
(B) The Ministry of Earth Sciences
(C) The respective State Wetland Authority
(D) The local Panchayat alone

2007

62. Poaching of hard corals (order Scleractinia) from Indian waters is a punishable offense under the Wildlife (Protection) Act, 1972. They are listed under:
(A) Schedule II
(B) Schedule I
(C) Schedule III
(D) Schedule VI

2023

63. Match the International Conventions in List I with their specific focal areas in List II:
List I: (Convention)
P. Ramsar Convention
Q. CITES
R. CBD
S. Executive Secretary UNFCCC
List II: (Focal Area)
1. International trade of endangered species
2. Conservation of wetlands
3. Climate change mitigation and adaptation
4. Sustainable use of biological diversity
(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-4, Q-3, R-1, S-2
(D) P-3, Q-4, R-2, S-1

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(C) Expulsion of symbiotic zooxanthellae due to thermal stress on photosynthetic systems
(D) Viral infections targeting the structural integrity of the calcium carbonate skeleton

2007

15. Match the following IUCN Marine Protected Area (MPA) management categories in List I with their descriptions in List II:
List I: (MPA Category)
P. Category Ia
Q. Category II
R. Category III
S. Category VI
List II: (Description)
1. National Park: ecosystem protection and recreation
2. Strict Nature Reserve: strictly protected for research/monitoring
3. Protected area with sustainable use of natural resources
4. Natural Monument or Feature
(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-4, Q-3, R-2, S-1

2009

16. In the zonation framework of a UNESCO Man and the Biosphere (MAB) Reserve, which zone allows for ecologically sustainable human activities, applied research, and traditional resource use?
(A) The absolute core zone
(B) The buffer zone
(C) The transition area
(D) The exclusion zone

2012

17. Under the Coastal Regulation Zone (CRZ) notification in India, highly ecologically sensitive areas such as mangroves, corals, and turtle nesting grounds are classified under which category?
(A) CRZ-II
(B) CRZ-I
(C) CRZ-III
(D) CRZ-IV

2010

18. The "wise-use" concept mandated by the Wetland (Conservation and Management) Rules in India is fundamentally derived from the guidelines of which international framework?
(A) The Kyoto Protocol
(B) The Montreal Protocol
(C) The Basel Convention
(D) The Ramsar Convention

2018

19. Under the Wildlife (Protection) Act, 1972 of India, all species of marine turtles found in Indian waters are afforded the highest level of legal protection by being listed in which schedule?
(A) Schedule I
(B) Schedule III
(C) Schedule IV
(D) Schedule V

2017

20. Which international convention strictly regulates the cross-border trade of endangered species, including the hard corals (Scleractinia) and marine turtles, to prevent their over-exploitation?
(A) UNFCCC
(B) UNCLOS
(C) CITES
(D) CMS

2016

21. When conducting mangrove afforestation as an ecological restoration technique, why is the hydrological restoration of the tidal regime considered a critical first step?
(A) Tidal flushing regulates salinity and facilitates natural propagule dispersal
(B) Mangroves require continuous freshwater immersion to trigger initial seed growth
(C) Artificial tidal regimes kill invasive terrestrial weeds through sudden immersion
(D) High tides force atmospheric nitrogen directly into the active root pneumatophores

NODIA

2021

22. Integrated Coastal Zone Management (ICZM) is best characterized by which of the following operational principles?
(A) A sector-by-sector management approach isolating fisheries from tourism industries
(B) A top-down, non-participatory framework excluding all local coastal communities
(C) A strategy focused on maximizing industrial output regardless of the ecological cost
(D) A holistic approach integrating land-sea interactions and multiple stakeholder interests

2007

23. Which criteria are primarily utilized by the Ministry of Environment, Forest and Climate Change (MoEFCC) in India to identify and

NODIA

2023

73. Sediment dynamics in coastal mudflats are predominantly governed by:
(A) Low-energy tidal currents promoting the deposition of fine silts, clays, and organic matter
(B) High-energy wave action eroding coarse sand
(C) Continuous tectonic uplift and volcanic ash deposition
(D) Aeolian transport of massive sand dunes from the hinterland

2017

74. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): Salt marsh ecosystems are highly productive yet generally exhibit low species diversity in their flora.
Reason (R): Only a few highly specialized halophytic plants possess the physiological adaptations required to tolerate the extreme stressors of varying salinity and frequent tidal inundation.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2007

75. A freshwater wetland designated as a Ramsar site must meet specific criteria. Which of the following is an incorrect criterion for Ramsar designation?
(A) It supports vulnerable, endangered, or critically endangered species.
(B) It regularly supports 20,000 or more waterbirds.
(C) It is entirely man-made and completely devoid of any natural ecological functions.
(D) It is an important source of food for fishes, spawning ground, nursery, and/or migration path.

2009

76. During the "arribada", tens of thousands of female Olive Ridley turtles aggregate to nest simultaneously. What is the hypothesized primary evolutionary advantage of this behavior?
(A) Predator satiation ensuring higher survival for eggs and hatchlings
(B) To increase competition among nesting females for optimal nest sites
(C) To allow females to incubate each other's eggs communally
(D) To physically alter the beach morphology to prevent high tides from reaching the nests

2003

77. The spawning ecology of the horseshoe crab (Tachypleus gigas) along the Indian coast is closely synchronized with:
(A) The onset of the dry season in inland terrestrial forests
(B) The full moon and new moon spring tides
(C) The daily cycle of solar radiation peaking at noon
(D) The irregular occurrences of offshore tsunamis

2001

78. Destructive fishing practices like blast fishing severely damage Ecologically Sensitive Areas by:
(A) Selectively targeting only apex predators without collateral damage
(B) Pulverizing coral framework and killing non-target organisms via shock waves
(C) Inducing temporary localized upwelling that ultimately benefits phytoplankton
(D) Removing only the top layer of seagrass leaves, stimulating faster regrowth

2019

79. Ocean acidification alters oceanic parameters by shifting the equilibrium of the carbonate buffer system. Which specific change poses the greatest threat to marine calcifiers?
(A) Significant decrease in the availability of carbonate ions in seawater
(B) A dramatic increase in the concentration of dissolved oxygen
(C) An exponential increase in seawater pH
(D) The complete precipitation of sodium chloride from the water column

2018

80. The core zone of a Marine Protected Area (MPA) designated as an IUCN Category Ia (Strict Nature Reserve) is primarily established to:
(A) Maximize commercial fishery yields through intensive and industrial-scale aquaculture.
(B) Protect biodiversity and strictly limit human use to preserve natural ecological processes.
(C) Provide a sheltered area for large-scale maritime shipping anchorages and commerce.
(D) Serve as a designated dumping ground for processed and dredged coastal sediment

2009

116. The Great Barrier Reef is the world's largest coral reef system. It is geomorphologically classified primarily as a:
(A) Barrier reef system
(B) Fringing reef system
(C) Massive solitary atoll
(D) Freshwater reef

2012

117. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): Ahermatypic corals are not restricted to the shallow photic zone.
Reason (R): They lack symbiotic zooxanthellae and therefore do not require sunlight for photosynthesis, allowing them to inhabit deep, cold oceanic waters.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2011

118. Which statement best describes the role of seagrasses as ecosystem engineers?
(A) Rhizomes stabilize sediments and canopies slow currents to promote deposition
(B) They aggressively secrete toxins that kill all competing benthic species
(C) They actively dig complex tunnel systems in the mud using their roots
(D) They physically lift heavy boulders to construct barriers against tidal flow

2012

119. In coastal sand dune ecology, what is the primary role of pioneer psammophytic species like Spinifex littoreus?
(A) To trap wind-blown sand, stabilize the foredune, and initiate primary succession
(B) To rapidly fix atmospheric nitrogen and acidify the sandy soil
(C) To provide a dense canopy shade that prevents any other plants from growing
(D) To attract large mammalian herbivores that compact the sand

2022

120. Which environmental factor creates the pronounced tidal zonation patterns observed in salt marsh halophyte communities?
(A) Physical stress gradients interacting with interspecific plant competition
(B) The uniform distribution of soil nutrients across the marsh
(C) The random dispersal of seeds by migratory wading birds
(D) The selective herbivory by marine fish during high tide

2018

121. The term "hydric soil" in wetland classification specifically indicates a soil that is:
(A) Saturated or flooded during the growing season to develop anaerobic conditions
(B) Highly porous and incapable of holding water for more than an hour
(C) Composed entirely of un-decomposed sphagnum moss
(D) Permanently frozen, forming continuous coastal permafrost

2022

122. Which marine turtle species is known for having a flexible, leathery carapace lacking bony scutes?
(A) Dermochelys coriacea
(B) Chelonia mydas
(C) Eretmochelys imbricata
(D) Caretta caretta

2023

123. The Indian horseshoe crab species Carcinoscorpius rotundicauda is ecologically distinct from Tachypleus gigas because it is primarily found in:
(A) Estuarine and mangrove-fringed muddy habitats with fluctuating salinities
(B) Deep offshore oceanic trenches
(C) Rocky intertidal zones exposed to high surf
(D) Coral reef drop-offs in the clear waters of the Andaman Sea

2021

124. Dredging activities in estuarine environments cause severe ecological damage primarily through:
(A) Benthic habitat removal and sediment resuspension causing high turbidity
(B) The immediate cooling of the water column to sub-lethal temperatures
(C) The introduction of synthetic plastic polymers into the food web
(D) The direct and complete removal of dissolved oxygen from the entire water body

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IV. Acting as a "shock absorber" for protected areas.
V. Mandating the immediate eviction of all indigenous communities.

Which of the above factors are correct?
(A) I, II, and IV
(B) II, III, and V
(C) I, III, and IV
(D) II, IV, and V

2001

89. Ecotones often support a higher density of organisms than the adjacent biomes. This is a direct manifestation of:
(A) The Edge effect
(B) The Allee effect
(C) The Coriolis effect
(D) The Bottleneck effect

2002

90. Which of the following genera is globally recognized as the most widespread genus of true mangroves, known commonly as the "red mangrove"?
(A) Rhizophora
(B) Avicennia
(C) Sonneratia
(D) Bruguiera

2002

91. To excrete excess salt, some mangrove species have specialized salt glands. Where are these glands typically located?
(A) Embedded deep within the root cortex
(B) On the epidermal surface of the leaves
(C) Within the fleshy tissue of the hypocotyl
(D) Lining the inner surface of the pneumatophores

2004

92. Consider the following coral reef geomorphology:
I. Fringing reefs are separated from the shore by wide, deep lagoons.
II. Barrier reefs run parallel to the shore and are separated by a deep lagoon.
III. Atolls typically form atop submerged volcanic seamounts.
IV. The Great Barrier Reef is an example of an atoll.

Which of the above statements are incorrect?
(A) I and IV
(B) II and III
(C) I and III
(D) II and IV

NODIA

2018

93. Zooxanthellae belong to which broad taxonomic group of algae?
(A) Diatoms (Bacillariophyceae)
(B) Dinoflagellates (Dinophyceae)
(C) Green algae (Chlorophyta)
(D) Brown algae (Phaeophyceae)

2012

94. Seagrasses reproduce sexually in the marine environment. How is their pollen structurally adapted for submerged transport?
(A) Elongated, thread-like structures that rely on water currents for pollination
(B) It is highly buoyant and dispersed exclusively on the sea surface by wind
(C) It is enclosed in a heavy, calcified shell that sinks immediately to the sediment
(D) It is actively transported by herbivorous sea turtles

2016

95. The dominant primary producers on the surface of seemingly barren coastal mudflats are usually:
(A) Epipelic benthic diatoms and cyanobacteria forming microscopic biofilms
(B) Macroalgal kelp forests
(C) Expansive meadows of terrestrial grasses
(D) Floating mats of freshwater hyacinths

2008

96. Which physiological adaptation is critical for salt marsh halophytes to prevent the toxic accumulation of sodium ions in their cytoplasm?
(A) Compartmentalization of sodium ions into large cellular vacuoles
(B) Storing sodium in the chloroplasts to enhance photosynthesis
(C) Rapid synthesis of sodium-binding enzymes that neutralize the charge
(D) Complete inhibition of root water uptake

2023

97. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): The construction of large upstream dams severely impacts downstream estuarine wetlands.
Reason (R): Dams alter the natural hydrological flow and significantly reduce the sediment transport required to maintain wetland elevation against sea-level rise.
(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2021
98. Which specific parameter ultimately dictates the sex of developing marine turtle embryos?
(A) The ambient temperature of the sand during the middle third of the incubation period
(B) The salinity of the groundwater near the nest
(C) The genetic sex chromosomes inherited from the parents
(D) The depth of the nest relative to the high tide line alone

2009
99. The biomedical harvesting of horseshoe crab hemolymph currently faces ecological criticism primarily because:
(A) Bleeding results in significant post-release mortality and impacts on reproduction
(B) The process extracts a highly radioactive substance
(C) The crabs are immediately ground into fishmeal after bleeding
(D) It directly causes mass coral bleaching

2014
100. Habitat fragmentation in coastal ecosystems typically leads to:
(A) Increased vulnerability of isolated subpopulations to local extinction events
(B) Enhanced genetic diversity due to isolated speciation over very short time scales
(C) The rapid formation of continuous, pristine ecotones
(D) A significant increase in the home range size of benthic sessile organisms

2022
101. How does rising sea surface temperature directly compromise the structural integrity of existing coral reefs?
(A) Bleaching mortality stops calcification, leaving reefs open to erosion
(B) It causes the calcium carbonate framework to instantaneously dissolve into gas
(C) It promotes the overgrowth of hard corals, making the reef too heavy to support itself
(D) It triggers continuous underwater volcanic eruptions

2022
102. Which of the following best defines an IUCN Category II Marine Protected Area?
(A) National Parks protecting ecological processes while providing visitor opportunities
(B) A localized area focused strictly on sustainable artisanal fishing
(C) A managed resource protected area where industrial extraction is the primary goal
(D) A strictly protected scientific reserve with absolutely no public access allowed

2005
103. The primary international legal instrument that formally established the framework for designating Biosphere Reserves globally is:
(A) The UNESCO Man and the Biosphere (MAB) Programme
(B) The United Nations Convention on the Law of the Sea (UNCLOS)
(C) The International Convention for the Regulation of Whaling (ICRW)
(D) The Kyoto Protocol

2025
104. According to CRZ-2019 guidelines, coastal areas that are relatively undisturbed and do not fall under CRZ-I or CRZ-II are classified as:
(A) CRZ-III
(B) CRZ-IA
(C) CRZ-IVB
(D) CRZ-IV

2015
105. Match the ecosystem components in List I to their corresponding habitat or species in List II:
List I: (Ecosystem Component)
P. Pneumatophores
Q. Zooxanthellae
R. LAL Test
S. Arribada
List II: (Habitat/Species)
1. Horseshoe crabs
2. Marine Turtles
3. True Mangroves
4. Hermatypic Corals
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-2, R-3, S-4

2001
106. The "wise-use" principle of the Ramsar Convention explicitly advocates for:
(A) Maintaining ecological character through ecosystem approaches in sustainable

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development
(B) The complete prohibition of all human interaction with wetlands
(C) The rapid conversion of wetlands into high-yield agricultural lands
(D) The exclusive use of wetlands for industrial wastewater treatment

2002
107. Which species of horseshoe crab is most commonly found along the coastal mudflats of Odisha and West Bengal in India?
(A) Tachypleus gigas
(B) Limulus polyphemus
(C) Tachypleus tridentatus
(D) Carcinoscorpius rotundicauda

2022
108. CITES categorizes species into Appendices based on the level of threat from international trade. Scleractinian corals are generally listed under which Appendix, requiring export permits?
(A) Appendix II
(B) Appendix I
(C) Appendix III
(D) Appendix IV

2006
109. What is a significant ecological risk associated with using non-native species for coastal habitat restoration?
(A) Invasiveness outcompeting native flora and altering natural ecosystem dynamics
(B) They may fail to grow, thus wasting restoration funds without ecological harm
(C) They immediately interbreed with all local species, creating sterile hybrids
(D) They absorb too much carbon dioxide, causing localized ocean acidification

2013
110. Which of the following is a primary objective of deploying artificial reefs in degraded nearshore waters?
(A) To enhance local fisheries production and biodiversity by providing shelter and breeding grounds
(B) To facilitate commercial bottom trawling
(C) To create a barrier that completely blocks tidal flow into estuaries
(D) To serve as an underwater storage facility for hazardous waste

2025
111. Consider the following principles central to Integrated Coastal Zone Management (ICZM):
I. Adaptive management.
II. Sectoral isolation.
III. Ecosystem-based approach.
IV. Exclusion of traditional knowledge.
V. Broad public participation.
Which of the above principles are correct?
(A) I, III, and V
(B) II, IV, and V
(C) I, II, and III
(D) III, IV, and V

2011
112. The delineation of an Eco-Sensitive Zone (ESZ) primarily aims to restrict which type of activities in the immediate vicinity of a protected area?
(A) Commercial mining, large hydroelectric projects, and polluting industries
(B) Traditional agriculture by local communities
(C) Non-consumptive scientific research
(D) The natural migration of wildlife species

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2008
113. Blue carbon is primarily sequestered in which specific component of a seagrass ecosystem?
(A) The anoxic sediments where root, rhizome, and trapped allochthonous organic matter accumulate
(B) The rapidly decomposing leaf blades floating on the surface
(C) The calcium carbonate shells of epiphytic gastropods
(D) The dissolved inorganic carbon in the surrounding water column

2019
114. Which statement represents the most accurate taxonomy of the Indian mangrove ecosystem?
(A) It consists solely of the genus Rhizophora
(B) Diverse true mangrove families alongside various associates
(C) It is dominated exclusively by gymnosperms
(D) It contains no true mangroves, only highly tolerant terrestrial associates

2014
115. A characteristic physiological adaptation of the mangrove species Bruguiera gymnorhiza to its anoxic soil environment is the development of:
(A) Knee roots (pneumatophores) that loop above and below the soil surface
(B) Tall, arching stilt roots from the main stem
(C) Massive floating leaves to absorb atmospheric oxygen directly
(D) Subterranean tubers that store pure oxygen gas

loads.

2008

81. In the UNESCO MAB framework, what defines the spatial relationship between the core, buffer, and transition zones?
(A) The buffer zone adjoins the core and is surrounded by the transition area
(B) They are entirely separate geographical entities located hundreds of kilometers apart
(C) The transition area is located in the center, completely enclosed by the core zone
(D) The zones are vertically stratified within the water column, irrespective of lateral boundaries

2014

82. Which statement regarding the demarcation of the Low Tide Line (LTL) for CRZ notifications is most accurate?
(A) It is defined by the line marking the lowest point reached by the water during the lowest astronomical tide
(B) It is estimated solely based on historical anecdotal accounts of local fishermen
(C) It corresponds exactly to the 20-meter bathymetric depth contour
(D) It is an arbitrary straight line drawn exactly 10 kilometers offshore

2006

83. The Wetland (Conservation and Management) Rules do not apply to which of the following categories of water bodies?
(A) High altitude lakes in the Himalayas
(B) Coastal lagoons and backwaters
(C) River channels explicitly and man-made agricultural tanks
(D) Inland saline lakes

2004

84. Match the following marine species in List I to their listing under the Wildlife (Protection) Act, 1972 in List II:
List I: (Species)
P. Dugong dugon
Q. Dermochelys coriacea
R. All Scleractinian corals
S. Carcinoscorpius rotundicauda
List II: (Schedule)
1. Schedule I
2. Schedule I
3. Schedule I
4. Schedule IV
(A) P-1, Q-2, R-3, S-4
(B) P-4, Q-3, R-2, S-1
(C) P-2, Q-4, R-1, S-3
(D) P-3, Q-1, R-4, S-2

2019

85. The application of the Convention on Biological Diversity (CBD) to marine habitats is significantly operationalized through which specific programmatic framework adopted by the convention?
(A) The Jakarta Mandate on Marine and Coastal Biological Diversity
(B) The Montreal Protocol on Substances that Deplete the Ozone Layer
(C) The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes
(D) The Minamata Convention on Mercury

2024

86. Which method is most critical for the successful ecological restoration of coral reefs via transplantation?
(A) Securely attaching coral fragments to stable substrates in good water quality
(B) Transplanting fragments to areas with high sedimentation and heavy macroalgal overgrowth to test resilience
(C) Using pure copper wire to tie fragments to bare sand
(D) Bleaching the coral fragments chemically before outplanting to ensure they are clean

2010

87. In the context of ICZM, identifying conflicts between competing coastal uses (e.g., tourism vs. aquaculture) is managed through:
(A) Marine Spatial Planning (MSP) to allocate distinct zones and temporal periods for specific activities
(B) Judicial decrees eliminating one of the competing sectors entirely
(C) Allowing the most financially lucrative industry to dictate all coastal policies
(D) Ignoring the conflict until one sector voluntarily relocates inland

2007

88. Consider the following factors driving the establishment of Eco-Sensitive Zones (ESZs):
I. Mitigating human-wildlife conflict.
II. Regulating unrestricted mining near protected areas.
III. Ensuring a completely sterile zone devoid of any biological activity.

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2003

125. Consider the following statements regarding climate change impacts on coastal ecosystems:

I. Ocean acidification hinders the ability of corals to accrete calcium carbonate.

II. Sea-level rise threatens the nesting beaches of marine turtles.

III. Increased sea surface temperatures prevent coral bleaching.

IV. Altered ocean currents can disrupt the dispersal of marine larvae.

Which of the above statements are correct?

(A) I, II, and IV
(B) II, III, and IV
(C) I, III, and IV
(D) I, II, and III

2025

126. Match the following Indian Marine Protected Areas (MPAs) in List I with their geographical location in List II:

List I: (MPA)

P. Gulf of Kutch Marine National Park
Q. Gulf of Mannar Marine National Park
R. Gahirmatha Marine Sanctuary
S. Mahatma Gandhi Marine National Park

List II: (Location)

1. Andaman & Nicobar Islands
2. Tamil Nadu
3. Odisha
4. Gujarat

(A) P-4, Q-2, R-3, S-1
(B) P-2, Q-4, R-1, S-3
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-3, R-2, S-4

2018

127. The primary objective of the Transition Area in a Biosphere Reserve is to:

(A) Serve as a zone of cooperation where sustainable resource management practices are developed and implemented with local communities
(B) Exclude all human presence permanently
(C) Provide a barrier against invasive terrestrial species entering the core
(D) Function strictly as a military testing ground

2009

128. According to the Coastal Regulation Zone (CRZ) rules, the area between the Low Tide Line (LTL) and the High Tide Line (HTL) is generally designated as:

(A) CRZ-I B
(B) CRZ-II
(C) CRZ-IV A
(D) CRZ-III B

2003

129. The Ramsar Convention's "Montreux Record" is a register of wetland sites that:

(A) Are currently experiencing, or are likely to experience, changes in ecological character due to technological developments, pollution, or other human interference
(B) Have achieved pristine ecological status
(C) Have been fully converted into urban landscapes
(D) Are entirely man-made and serve only industrial purposes

2009

130. Under the Wildlife (Protection) Act, 1972, which of the following actions regarding Schedule I species (like the Olive Ridley turtle) is legally permitted?

(A) Hunting is strictly prohibited, except under rare circumstances such as for specific scientific research permitted by the Chief Wildlife Warden
(B) Commercial hunting during a designated open season
(C) Trade of derivative products, provided they are certified
(D) Keeping them as exotic pets without any documentation

NODIA

2019

131. Which of the following best defines the application of the Precautionary Principle in International environmental treaties affecting coastal habitats?

(A) Lack of scientific certainty shall not postpone measures to prevent degradation
(B) Action to prevent environmental degradation should only be taken when there is absolute scientific certainty of harm
(C) Economic development always takes precedence over environmental concerns unless species extinction is actively occurring
(D) Environmental treaties apply only to areas explicitly defined as pristine

2014

132. Mangrove afforestation techniques often utilize "propagule planting". What is a critical factor for the high survival rate of planted Rhizophora propagules?

(A) Correct tidal elevation to ensure appropriate periods of inundation and exposure

(B) Planting them entirely submerged in high-energy subtidal zones
(C) Drying them completely in the sun for two weeks prior to planting
(D) Planting them in pure, unmixed terrestrial topsoil

2025

133. Which component is fundamentally necessary for the spatial planning process in Integrated Coastal Zone Management (ICZM)?
(A) Mapping resources, human uses, and jurisdictional boundaries using GIS
(B) The immediate ban of all commercial fishing vessels
(C) The construction of seawalls along the entire coastal length
(D) The exclusive reliance on historical nautical charts from the 19th century

2023

134. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): Ecologically Sensitive Areas (ESAs) are dynamic entities that can shift their geographical boundaries over time.
Reason (R): Natural processes such as deltaic accretion, sea-level rise, and ecological succession continually alter the physical and biological characteristics of coastal landscapes.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2016

135. Consider the following statements regarding ecotones:
I. Ecotones are sharp, narrow, and absolute boundaries between two ecosystems with no species overlap.
II. Estuaries function as major ecotones between freshwater rivers and the marine environment.
III. Organisms found in ecotones are often highly adaptable to fluctuating environmental conditions.
IV. The edge effect typically results in lower biodiversity within the ecotone compared to the adjacent communities.
Which of the above statements are incorrect?
(A) I and IV
(B) I and II
(C) II and III
(D) III and IV

2002

136. The structural complexity of a mangrove forest provides critical ecosystem services. Which of the following is NOT a primary ecosystem service provided by mangroves?
(A) Serving as a major source of commercial limestone extraction
(B) Coastal protection from storm surges and cyclonic winds
(C) Trapping riverine sediments and reducing coastal turbidity
(D) Providing nursery grounds for juvenile commercial fish and crustaceans

2025

137. Which specific anatomical feature enables mangrove leaves to minimize water loss in an environment where fresh water is physiologically scarce?
(A) Waxy cuticles, sunken stomata, and succulent leaf tissues
(B) Broad, extremely thin leaf blades with high stomatal density on the upper surface
(C) Complete absence of an epidermis
(D) Continuous shedding of leaves every single day

2022

138. The zonation of coral reefs typically includes the reef flat, reef crest, and fore-reef slope. Which zone experiences the highest wave energy and is usually dominated by robust, branching, or encrusting corals?
(A) The reef crest
(B) The shallow, sheltered lagoon
(C) The deep fore-reef slope
(D) The back-reef flat

2025

139. Which biogeochemical process is primarily responsible for the rapid growth and massive framework construction of hermatypic coral reefs in nutrient-poor tropical waters?
(A) Efficient recycling of nutrients between host and symbiotic zooxanthellae
(B) Anaerobic methanogenesis
(C) Continuous, massive upwelling of macro-nutrients from the deep ocean floor
(D) The direct absorption of dissolved limestone from passing oceanic currents

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2024

140. Match the physiological adaptation in List I to its specific coastal ecosystem flora in List II:

List I: (Physiological Adaptation)

P. Aerenchyma tissue

Q. Salt glands on leaves

R. Vivipary

S. Submerged hydrophilous pollination

List II: (Ecosystem Flora)

1. Mangroves
2. Seagrasses
3. Freshwater Hydrophytes
4. Salt Marsh Halophytes

(A) P-3, Q-4, R-1, S-2
(B) P-1, Q-2, R-3, S-4
(C) P-4, Q-3, R-1, S-2
(D) P-3, Q-1, R-4, S-2

2024

141. The epifauna of a coastal mudflat differs from the infauna primarily in that:

(A) Epifauna live on the sediment surface, while infauna are burrowing organisms living within the sediment
(B) Epifauna live buried within the anoxic sediment, while infauna live on the sediment surface
(C) Epifauna are exclusively microscopic, while infauna are macroscopic
(D) Epifauna are all primary producers, while infauna are all apex predators

2014

142. Which physical factor primarily dictates the transition from a lower salt marsh zone to an upper salt marsh zone?

(A) The reduction in the frequency and duration of tidal inundation
(B) The gradient of wind exposure
(C) The immediate shift from highly saline soil to pure freshwater soil
(D) The transition from muddy substrate to solid granite bedrock

2025

143. Which of the following best categorizes a "bocage" landscape often associated with specific types of human-modified wetland ecosystems?

(A) A network of hedgerows, ditches, and fragmented marshlands traditionally managed for agriculture and grazing
(B) A pristine, untouched marine coral reef
(C) A heavily urbanized coastline with no natural vegetation
(D) A deep-sea hydrothermal vent community

2017

144. Marine turtles possess specialized salt glands to excrete excess salt ingested from seawater. Where are these glands anatomically located?

(A) In the lacrimal (tear) ducts near the eyes
(B) Near the cloaca
(C) Along the marginal scutes of the carapace
(D) Underneath the tongue

2015

145. Consider the following statements regarding horseshoe crabs:

I. They are true decapod crustaceans closely related to true crabs.
II. Their blood is blue due to the presence of copper-based hemocyanin.
III. They possess a long, stiff tail called a telson, used primarily to flip themselves right-side up.
IV. Tachypleus gigas is an endangered species found in India.
V. They spawn primarily in the deep open ocean.

Which of the above statements are correct?

(A) II, III, and IV
(B) I, II, and III
(C) III, IV, and V
(D) I, IV, and V

2025

146. How does coastal eutrophication directly contribute to the loss of seagrass beds?

(A) Blooms reduce light penetration, starving the benthic seagrasses of sunlight
(B) It causes the seagrass leaves to grow too rapidly, breaking under wave action
(C) The excess nutrients become toxic and directly dissolve the seagrass rhizomes
(D) It dramatically increases the salinity of the estuary, killing the osmotically sensitive seagrasses

2007

147. The "coastal squeeze" phenomenon, exacerbated by climate change, describes the entrapment of coastal habitats between:

(A) Sea-level rise pushing habitats landward and fixed human infrastructure
(B) Expanding mangrove forests and retreating salt marshes
(C) High and low tide lines converging to eliminate the intertidal zone
(D) Expanding coral reefs and eroding sandy beaches

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2013

148. Which parameter is a fundamental requirement when delineating the boundaries of a new Marine Protected Area (MPA) designed for fisheries spillover?
(A) Inclusion of critical source habitats integrated into a broader dispersal network
(B) Complete enclosure of the MPA with physical underwater nets
(C) Designation of the MPA in an area completely devoid of commercially valuable fish
(D) Permitting heavy industrial dredging within the core zone to create artificial depth

2015

149. The UNESCO Man and the Biosphere (MAB) program specifically aims to:
(A) Establish a scientific basis for the improvement of relationships between people and their environments, promoting sustainable development
(B) Isolate local communities from their traditional environments to preserve nature
(C) Transform all global forests into strict, no-entry nature reserves
(D) Promote the unilateral commercial exploitation of genetic resources

2017

150. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): The CRZ-IV category includes the water area from the Low Tide Line to twelve nautical miles seaward.
Reason (R): This categorization is meant to regulate activities within the territorial waters of India, ensuring the protection of marine ecosystems like coral reefs and seagrass beds from unregulated maritime pollution and exploitation.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2018

151. Under the Wetland (Conservation and Management) Rules, 2017, the definition of a wetland specifically excludes:
(A) Paddy fields and human-made water bodies constructed specifically for drinking water purposes
(B) Mangrove swamps
(C) High altitude glacial lakes
(D) Estuarine backwaters

2001

152. Which Schedule of the Wildlife (Protection) Act, 1972 is specifically designed to provide absolute protection, where offenses carry the highest penalties, to highly endangered species like the marine turtles and Dugongs?
(A) Schedule I
(B) Schedule V
(C) Schedule III
(D) Schedule IV

2005

153. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) operates by:
(A) Licensing specimens of selected species defined by three Appendices
(B) Banning all international trade universally for all species
(C) Providing direct financial subsidies to poachers to stop hunting
(D) Establishing heavily armed international anti-poaching military units

NODIA

2024

154. What is a primary objective of deploying artificial coral reefs using Biorock technology?
(A) Electrical stimulation through frames to accelerate biogenic calcification
(B) To chemically dissolve existing dead reef framework
(C) To create a toxic boundary that keeps predatory starfish out
(D) To inject liquid calcium directly into the living coral polyps

2018

155. Which of the following elements is critical for the long-term success of Integrated Coastal Zone Management (ICZM) initiatives?
(A) Capacity building, stakeholder engagement, and adaptive management
(B) Strict adherence to a single-discipline scientific approach (e.g., only geology)
(C) Top-down implementation strictly by the central government without local consultation
(D) Relying entirely on short-term project funding without establishing a permanent institutional framework

2009

156. In the context of Eco-Sensitive Zones, "regulated activities" generally imply that:
(A) The activities are permitted but strictly monitored and managed to ensure they do not cause ecological degradation to the adjoining protected area
(B) The activities are completely banned under all circumstances
(C) The activities are promoted without any environmental checks
(D) The activities are left entirely to the discretion of private corporations

2011

157. Which specific characteristic of the ecotone between a mangrove forest and an adjacent seagrass bed drives high secondary productivity?
(A) Mangrove organic detritus fueling detritivorous food webs in seagrasses
(B) The complete absence of predators in the ecotone
(C) The highly toxic nature of the ecotonal sediments that select only for giant organisms
(D) The extreme depth of the ecotone preventing light penetration

2012

158. Which of the following statements is incorrect regarding the taxonomy and distribution of Indian mangroves?
(A) The Sundarbans delta is the only mangrove habitat in the world where the Bengal tiger is found.
(B) Heritiera fomes (Sundari tree) is a dominant species in the freshwater-influenced regions of the Sundarbans.
(C) Mangrove species diversity in India is significantly higher on the western coast compared to the eastern coast.
(D) The Pichavaram mangrove forest in Tamil Nadu is dominated primarily by Avicennia and Rhizophora species.

2005

159. The specialized root system of the mangrove genus Sonneratia is characterized primarily by:
(A) Spike-like pneumatophores radiating from horizontal cable roots
(B) Stilt roots
(C) Buttress roots
(D) Knee roots

2007

160. Match the Coral Reef type in List I with its appropriate description in List II:
List I: (Coral Reef Type)
P. Fringing Reef
Q. Barrier Reef
R. Atoll
S. Patch Reef
List II: (Description)
1. Small, isolated reef often found within lagoons
2. Reef separated from land by a deep, wide lagoon
3. Circular reef enclosing a central lagoon without an island
4. Reef directly attached to the shore
(A) P-4, Q-2, R-3, S-1
(B) P-2, Q-1, R-4, S-3
(C) P-3, Q-4, R-1, S-2
(D) P-1, Q-3, R-2, S-4

2018

161. In scleractinian corals, the process of biogenic calcification is tightly coupled with:
(A) Photosynthetic activity of symbiotic zooxanthellae altering local chemistry
(B) The bioluminescence of the coral polyps
(C) The rapid digestion of small fish in the coral's gastrovascular cavity
(D) The continuous mechanical grinding of nearby sand particles by coral tentacles

2004

162. Seagrasses ecosystems are vulnerable to "wasting disease", historically a major cause of massive die-offs. This disease is primarily caused by which type of pathogen?
(A) A marine protist in the genus Labyrinthula
(B) A toxic dinoflagellate
(C) A virulent strain of marine cyanobacteria
(D) A parasitic marine nematode

2014

163. The vertical stratification of infauna in coastal mudflats is primarily determined by:
(A) The steep gradient of dissolved oxygen availability in the interstitial water, creating distinct aerobic and anaerobic zones
(B) The intense light penetration reaching several meters into the mud
(C) The exclusive presence of large submerged tree roots
(D) The extreme fluctuations in surface air temperature

2018

164. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason

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(R). Select the correct answer from the options given below:
Assertion (A): Salt marsh grasses are vital for mitigating coastal erosion.
Reason (R): Their dense aboveground biomass attenuates wave energy, while their extensive rhizome networks physically bind the estuarine sediments together.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2015
165. The Ramsar Classification System divides wetlands into three broad categories. Which of the following accurately lists these three main categories?
(A) Marine/Coastal, Inland, and Human-made wetlands
(B) Tropical, Temperate, and Polar wetlands
(C) Ephemeral, Permanent, and Subterranean wetlands
(D) Forested, Scrub-shrub, and Emergent wetlands

2014
166. Marine turtle nesting success is often severely compromised by artificial beach lighting. What is the primary ecological mechanism of this impact?
(A) Disorienting newly emerged hatchlings and leading them away from the sea
(B) It causes the adult turtles to become permanently blind
(C) It dramatically raises the temperature of the sand, altering the sex ratio
(D) It attracts swarms of parasitic insects that consume the eggs

2013
167. The horseshoe crab utilizes its specialized appendage, the telson, primarily for which function?
(A) Righting itself when flipped onto its carapace by wave action
(B) Stinging potential predators with venom
(C) Piercing the shells of bivalve prey
(D) Sensing the magnetic field of the earth for long-distance migration

2014
168. Which Anthropogenic activity is most directly responsible for the extensive loss of mangrove habitats globally over the past few decades?
(A) Conversion into commercial aquaculture ponds for shrimp farming
(B) Artisanal pole-and-line fishing
(C) Harvesting of mangrove honey by indigenous tribes
(D) Establishment of non-consumptive ecotourism boardwalks

2018
169. Global climate change impacts seagrass beds through sea-level rise primarily by:
(A) Increasing water depth and reducing available radiation for photosynthesis
(B) Freezing the water column over the seagrass canopy
(C) Chemically converting the seagrass rhizomes into pure carbon
(D) Inducing spontaneous mutations that turn seagrasses into macroalgae

2007
170. Which of the following is a fundamental limitation of "paper parks" in the context of Marine Protected Areas?
(A) Legal designation without effective management or financial resources
(B) They are established exclusively using paper-based maps without GIS
(C) They only protect species that can be legally harvested for the paper industry
(D) They are temporary MPAs that exist only for one calendar year

NODIA

2015
171. The "core area" of a Biosphere Reserve must possess which defining characteristic?
(A) It must be a legally protected site for conserving biological diversity, monitoring minimally disturbed ecosystems, and undertaking non-destructive research
(B) It must be entirely devoid of any endemic species
(C) It must allow unrestricted access for mass tourism and heavy recreation
(D) It must be primarily dedicated to the commercial extraction of timber

2013
172. Under the CRZ-2019 notification, the No Development Zone (NDZ) for a densely populated rural area (CRZ-III A) is delineated up to how many meters from the High Tide Line?

(A) 500 meters
(B) 200 meters
(C) 50 meters
(D) 10 meters

2019

173. The primary institutional authority created to implement the Wetland (Conservation and Management) Rules at the national level, providing policy guidelines, is the:
(A) National Wetland Committee
(B) National Green Tribunal
(C) Central Pollution Control Board
(D) Zoological Survey of India

2009

174. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): The harvesting of horseshoe crabs in India is strictly prohibited under the Wildlife (Protection) Act, 1972.
Reason (R): Horseshoe crabs are currently listed under Schedule IV of the Act, which completely bans any capture, trade, or utilization of the species, even for biomedical research.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2022

175. The Convention on Biological Diversity (CBD) advocates for "In-situ conservation". Which of the following actions exemplifies this?
(A) Establishing a Marine Protected Area to safeguard a critical coral reef habitat within its natural environment
(B) Storing marine turtle embryos in a cryogenic facility
(C) Cultivating endangered mangrove species exclusively in a botanical garden greenhouse
(D) Capturing the last remaining individuals of a species to keep them in an aquarium

2013

176. Which technique is most commonly employed in the ecological rehabilitation of highly degraded, hypersaline salt pans to restore functional salt marsh ecosystems?
(A) Establishing historical tidal hydrology by breaching artificial levees
(B) The massive application of chemical herbicides to clear all vegetation
(C) The permanent covering of the salt pans with concrete to prevent further salinization
(D) The introduction of exclusively freshwater amphibian species

2025

177. The success of an ICZM framework relies heavily on identifying "setback lines". What is the primary purpose of a setback line in coastal planning?
(A) Safeguarding life and property while allowing natural coastal processes
(B) To mark the absolute limit of territorial waters
(C) To outline the boundary for exclusive commercial shipping lanes
(D) To dictate where deep-sea mining can legally commence

2013

178. Ecologically Sensitive Areas (ESAs) in the Western Ghats were prominently assessed and demarcated by specific high-level expert panels. Which two prominent committees are associated with this task?
(A) The Gadgil Committee and the Kasturirangan Committee
(B) The Swaminathan Committee and the Kasturirangan Committee
(C) The Tendulkar Committee and the Rangarajan Committee
(D) The Kelkar Committee and the Gadgil Committee

2016

179. In an estuarine ecotone, the phenomenon where a steep salinity gradient prevents the immediate mixing of fresh and marine waters, leading to vertical stratification, is called a:
(A) Halocline
(B) Thermocline
(C) Pycnocline
(D) Chemocline

2022

180. Match the mangrove genus in List I with its characteristic physiological or morphological feature in List II:
List I: (Mangrove Genus)
P. Rhizophora
Q. Avicennia
R. Heritiera
S. Nypa

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Which of the following represents the correct sequential order from the most environmentally sensitive to the zone designated for territorial waters?
(A) I, II, III, IV
(B) I, IV, II, III
(C) I, III, II, IV
(D) III, IV, II, I

2023
196. The "wise-use" principle of the Ramsar Convention emphasizes managing wetlands through an ecosystem approach. Which action violates this principle?
(A) Draining a wetland entirely to build a commercial shopping complex
(B) Regulated rotational grazing on the peripheral floodplain
(C) Promoting low-impact ecotourism and bird watching
(D) Harvesting specific reeds at sustainable rates for local handicrafts

2019
197. Which of the following marine species is specifically protected under Schedule I of the Wildlife (Protection) Act, 1972, making its hunting or trade a severe criminal offense?
(A) The Indian mackerel (Rastrelliger kanagurta)
(B) The Whale shark (Rhincodon typus)
(C) The Bombay duck (Harpadon nehereus)
(D) The Green mussel (Perna viridis)

2015
198. How does the Convention on Biological Diversity (CBD) specifically define "biological diversity"?
(A) The variability among living organisms from all sources including terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part
(B) Only the variety of animal species present in tropical rainforests
(C) The total number of purely endemic species found within a political boundary
(D) The genetic differences found exclusively within commercially cultivated agricultural crops

2009
199. When restoring a degraded coral reef, the "nursery phase" of coral gardening primarily aims to:
(A) Maximizing growth and survivorship in protected environments before reef outplanting
(B) Isolate corals from all marine life in land-based aquariums permanently
(C) Genetically modify corals using advanced CRISPR techniques to tolerate boiling water
(D) Grow massive coral colonies to be harvested and sold for the jewelry trade to fund conservation

2025
200. The concept of "co-management" in Integrated Coastal Zone Management (ICZM) refers to:
(A) The sharing of power and responsibility for resource management between the government and local resource users
(B) The management of the coast exclusively by two different multinational corporations
(C) The complete transfer of all regulatory authority from the government to unregulated private individuals
(D) The simultaneous implementation of opposing policies by different state departments

2002
201. Which specific feature is primarily evaluated when determining the ecological significance of a proposed Eco-Sensitive Area (ESA)?
(A) Its capacity to provide vital ecosystem services, act as a biological corridor, and harbor rare or endangered taxa
(B) The proximity to a major international airport
(C) Its suitability for large-scale monoculture plantation forestry
(D) The absolute absence of any underground aquifers

2001
202. Which of the following accurately describes a characteristic of an "edge effect" in a coastal ecotone?
(A) The transition zone often exhibits greater species diversity and higher population densities than either of the adjacent discrete ecosystems
(B) The transition zone contains only species identical to the two adjacent ecosystems without any unique species
(C) The transition zone is universally characterized by a complete lack of biological activity
(D) The transition zone rapidly eliminates all forms of primary productivity

NODIA

the migratory Siberian Crane, and is listed in the Montreux Record?
(A) Keoladeo National Park
(B) Chilika Lake
(C) Loktak Lake
(D) Vembanad Kol Wetland

2022

189. During the incubation of marine turtle eggs, what role does the precise depth of the nest chamber play?
(A) Buffering eggs against temperature fluctuations and influencing sex ratio
(B) It has absolutely no effect on the development of the embryos
(C) It ensures the eggs are permanently submerged in the groundwater table
(D) It prevents the hatchlings from ever reaching the surface, thereby controlling population explosions

2005

190. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): The biomedical industry's reliance on horseshoe crabs is unsustainable in its current unregulated forms.
Reason (R): Extensive harvesting has led to significant population declines due to bleeding mortality and impaired reproductive fitness in released crabs, threatening both the species and the migratory shorebirds that rely on their eggs.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

191. Anthropogenic habitat fragmentation in estuarine ecosystems is most frequently caused by:
(A) Infrastructure like tidal barrages severing hydrological connectivity
(B) The natural shifting of sandbars during monsoon storms
(C) The localized grazing of manatees and dugongs in seagrass beds
(D) The predictable seasonal die-back of annual salt marsh vegetation

2004

192. Which mechanism explains how ocean acidification negatively impacts the behavioral ecology of marine fishes, particularly reef-associated species?
(A) It disrupts olfactory and auditory processing, impairing predator detection
(B) It dissolves their scales, rendering them completely immobile
(C) It increases the water density so significantly that fish can no longer swim downwards
(D) It forces all marine fish to rapidly evolve lungs to breathe atmospheric air

2006

193. What is the primary operational distinction between a "No-Take Zone" and a "Multiple-Use Zone" within a Marine Protected Area (MPA)?
(A) No-Take Zones prohibit all forms of extractive activities, including fishing, whereas Multiple-Use Zones allow regulated levels of exploitation alongside conservation
(B) No-Take Zones are restricted exclusively to deep-sea environments, while Multiple-Use Zones are only coastal
(C) No-Take Zones allow commercial fishing but ban recreational fishing, whereas Multiple-Use Zones ban all fishing
(D) No-Take Zones are temporary seasonal closures, while Multiple-Use Zones are permanent closures

2004

194. The Nilgiri Biosphere Reserve, India's first biosphere reserve, falls under the UNESCO MAB network. Which of the following is NOT a fundamental function of a Biosphere Reserve under this framework?
(A) Complete militarization of the transition zone to prevent international border incursions
(B) Conservation of biodiversity and cultural diversity
(C) Economic development that is socio-culturally and environmentally sustainable
(D) Logistic support for research, monitoring, environmental education, and training

2014

195. Consider the following Coastal Regulation Zones (CRZ):
I. CRZ-I
II. CRZ-III
III. CRZ-II
IV. CRZ-IV

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List II: (Characteristic Feature)

1. Palm-like morphology, lacking a true woody trunk above ground
2. Distinctive stilt roots and prominent viviparous hypocotyls
3. Dense fields of spike-like pneumatophores and salt-excreting leaves
4. Blind root pegs (pneumatophores) and primarily found in low salinity zones

(A) P-2, Q-3, R-4, S-1
(B) P-3, Q-2, R-1, S-4
(C) P-4, Q-1, R-2, S-3
(D) P-1, Q-4, R-3, S-2

2011

181. The specialized structures in the roots of salt-excluding mangroves that block the passive uptake of sodium ions while allowing water to pass through are located in the:
(A) Casparian strip of the endodermis
(B) Epidermis
(C) Xylem vessels
(D) Apical meristem

2013

182. Coral bleaching is fundamentally triggered when environmental stress causes:
(A) Symbiotic zooxanthellae expulsion or loss of photosynthetic pigments
(B) The coral to secrete a thick layer of white mucus over its skeleton
(C) The immediate dissolution of the calcium carbonate skeleton by acidic ocean water
(D) A viral infection that turns the coral tissue permanently transparent

2002

183. Which of the following statements is incorrect concerning ahermatypic corals?
(A) They are commonly referred to as non-reef-building corals.
(B) They can possess symbiotic zooxanthellae, but generally lack them, especially in deep waters.
(C) They are strictly limited to the shallow, sunlit tropical photic zone.
(D) Some deep-water ahermatypic corals can form extensive, slow-growing cold-water coral mounds.

2017

184. Seagrasses act as bioindicators of coastal water quality primarily because:
(A) They are highly sensitive to changes in light attenuation caused by eutrophication and increased suspended sediments
(B) They are extremely resilient and thrive equally well in pristine and highly polluted waters
(C) They actively concentrate heavy metals in their leaves until they turn fluorescent
(D) They migrate rapidly out of polluted estuaries into the open ocean

NODIA

2024

185. Consider the following sequence of primary succession on a prograding coastal mudflat:
I. Colonization by epipelic diatoms stabilizing the surface.
II. Establishment of pioneer halophytes (e.g., Salicornia).
III. Deposition of fine silt and clay by gentle tidal action.
IV. Succession to complex salt marsh or mangrove communities.
Which of the following represents the correct chronological order?
(A) I, II, III, IV
(B) III, I, II, IV
(C) III, II, I, IV
(D) II, I, IV, III

2006

186. Which physiological challenge is uniquely faced by infauna living deep within a muddy coastal substrate?
(A) Anoxic conditions saturated with toxic hydrogen sulfide
(B) Continuous exposure to intense ultraviolet radiation
(C) Extreme fluctuations in surface wave energy
(D) Complete absence of organic detritus for feeding

2017

187. In Ramsar wetland classification, a "Peatland" is defined primarily by:
(A) The continuous accumulation of partially decayed organic matter under waterlogged, anoxic conditions
(B) Its geographic location at exactly the equator
(C) Its high alkalinity and complete lack of vegetative cover
(D) Its formation exclusively within the craters of extinct volcanoes

2006

188. Which Indian coastal wetland is famous for being a critically important wintering ground for

2004

203. Which of the following statements is incorrect regarding the global distribution of mangroves?
(A) Mangroves are restricted almost exclusively to tropical and subtropical latitudes because they are highly susceptible to freezing temperatures.
(B) The Indo-Pacific region harbors a significantly higher diversity of mangrove species compared to the Atlantic-Caribbean region.
(C) Mangroves achieve their greatest biomass and structural complexity in hyper-arid, hypersaline coastal deserts.
(D) Ocean currents play a major role in the global dispersal of buoyant mangrove propagules.

2024

204. The process by which true mangroves like Rhizophora exude excess salt from their sap via active transport mechanisms located in the leaves is termed:
(A) Salt secretion
(B) Salt exclusion
(C) Salt accumulation
(D) Salt sublimation

2002

205. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): Coral reefs are often called the "rainforests of the sea".
Reason (R): Despite existing in nutrient-poor waters, they exhibit exceptionally high gross primary productivity and support an immense diversity of marine life, rivaling terrestrial rainforests.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2001

206. Which morphological adaptation allows ahermatypic corals to survive in deep, aphotic zones?
(A) They lack symbiotic zooxanthellae and rely entirely on capturing passing zooplankton and suspended organic particulate matter using their tentacles
(B) They possess exceptionally large, transparent polyps to maximize light capture
(C) They grow extensive root systems into the deep-sea mud to absorb dissolved nutrients
(D) They migrate vertically to the surface every night to photosynthesize under the moonlight

2006

207. Seagrasses are highly susceptible to physical damage from "prop scarring". This phenomenon is caused by:
(A) The propellers of shallow-draft motorized boats cutting through the grass beds and ripping up the rhizome mats
(B) The aggressive burrowing of large benthic rays
(C) The natural, seasonal shedding of the older seagrass leaves
(D) The impact of heavy monsoon raindrops during low tide exposure

2017

208. Coastal sand dune ecosystems are highly dynamic. Which of the following is the critical factor necessary for the formation of a primary dune?
(A) The presence of pioneer sand-binding vegetation, such as Spinifex or Ipomoea, to trap aeolian (wind-blown) sand
(B) High levels of organic detritus washing ashore
(C) Continuous, deep-water oceanic inundation
(D) The presence of a massive coral reef immediately offshore

NODIA

2024

209. Halophytes in salt marshes employ various strategies to manage salinity. Which genus is well-known for accumulating water in fleshy tissues to dilute internal salt concentrations (succulence)?
(A) Salicornia
(B) Spartina
(C) Phragmites
(D) Typha

2004

210. Which Ramsar site in India is a unique floating national park characterized by "phumdis" (floating masses of vegetation, soil, and organic matter)?
(A) Keibul Lamjao National Park (Loktak Lake)
(B) Keoladeo National Park
(C) Wular Lake
(D) Ashtamudi Wetland

2009

211. Consider the following statements regarding marine turtles and their distinct ecological characteristics:

I. Chelonia mydas (Green turtle): Primarily herbivorous adults, grazing on seagrasses.

II. Dermochelys coriacea (Leatherback): Feeds almost exclusively on jellyfish and lacks a bony carapace.

III. Eretmochelys imbricata (Hawksbill): Lacks a beak and feeds exclusively on pelagic jellyfish.

IV. Lepidochelys olivacea (Olive Ridley): The largest of all marine turtles, strictly solitary nesters.

Which of the above statements are incorrect?

(A) I and II
(B) II and III
(C) III and IV
(D) I and IV

2002

212. What makes the biomedical extraction of horseshoe crab hemolymph potentially deleterious to the broader coastal ecosystem?

(A) High post-bleeding mortality reducing spawning events and starving migratory shorebirds
(B) It permanently alters the chemical composition of the seawater
(C) The process introduces lethal human pathogens directly into the estuarine mud
(D) It causes the crabs to mutate into aggressive, invasive predators

2022

213. Eutrophication in coastal waters often leads to "hypoxia", which is technically defined as:

(A) A condition where dissolved oxygen concentrations fall below the level necessary to sustain most marine animal life (typically below 2 mg/L)
(B) An over-saturation of dissolved oxygen, causing gas bubble disease in fish
(C) A rapid drop in water temperature below freezing
(D) A sudden increase in water clarity and primary productivity

2007

214. How does the process of ocean acidification physically impair the calcification mechanism of corals?

(A) Hydrogen ions react with carbonate ions, reducing aragonite saturation states
(B) It binds all available calcium into insoluble toxic heavy metal complexes
(C) It radically increases the pH of the ocean, causing the coral skeleton to spontaneously combust
(D) It kills the symbiotic zooxanthellae by exposing them to high concentrations of sulfuric acid

2011

215. Match the following terms in List I with their relevance to Marine Protected Areas (MPAs) in List II:

List I: (Term)

P. Spillover effect
Q. No-take zone
R. Connectivity
S. Paper park

List II: (Description)

1. Area legally designated but lacking effective enforcement
2. The net export of adult/juvenile biomass from an MPA to adjacent fished areas
3. The linkage of distinct habitats facilitating species life-cycle movements
4. A strictly protected area prohibiting all extractive activities

(A) P-2, Q-4, R-3, S-1
(B) P-1, Q-2, R-3, S-4
(C) P-4, Q-3, R-1, S-2
(D) P-3, Q-1, R-4, S-2

2023

216. The concept of "Zonation" in a UNESCO Biosphere Reserve is fundamentally designed to:

(A) Create a spatial framework balancing strict conservation (core) with sustainable use and human development (buffer and transition)
(B) Physically wall off indigenous people from natural resources
(C) Designate areas solely for high-intensity commercial logging
(D) Divide the reserve equally among competing multinational corporations

2011

217. Under the CRZ notification, activities such as the setting up of new industries and expansion of existing industries are generally:

(A) Prohibited within the CRZ, subject to specific exemptions for activities requiring foreshore facilities (e.g., ports)
(B) Encouraged in CRZ-I to boost local coastal economies
(C) Completely unrestricted across all CRZ

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categories
(D) Mandated to occur strictly within the 200-meter No Development Zone

2016
218. The "Montreux Record" is a mechanism operating under the aegis of which major international treaty?
(A) The Ramsar Convention on Wetlands
(B) The Convention on Biological Diversity (CBD)
(C) The United Nations Framework Convention on Climate Change (UNFCCC)
(D) The Convention on the Conservation of Migratory Species (CMS)

2005
219. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): The Wildlife (Protection) Act, 1972 allows for the hunting of specific Schedule I marine species if they become a danger to human life.
Reason (R): The Chief Wildlife Warden has the statutory authority to permit the hunting of any Schedule I animal if satisfied that it has become dangerous to human life or is so disabled or diseased as to be beyond recovery.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2001
220. The primary purpose of CITES (Convention on International Trade in Endangered Species) is to:
(A) Ensure that international trade in specimens of wild animals and plants does not threaten their survival in the wild
(B) Prevent the introduction of invasive alien species through global shipping ballast water
(C) Regulate the total allowable catch (TAC) for commercial high-seas fisheries
(D) Establish a global carbon trading market to combat climate change

2012
221. Which of the following is a vital prerequisite for the successful ecological restoration of a degraded coastal mangrove habitat?
(A) Assessment and restoration of local hydrological regimes and tidal frequencies
(B) The complete eradication of all native benthic fauna prior to planting
(C) The heavy application of synthetic nitrogenous fertilizers to the coastal mud
(D) The immediate construction of a concrete seawall around the planting site

2003
222. Marine Spatial Planning (MSP) is a core tool of Integrated Coastal Zone Management (ICZM). What is the main objective of MSP?
(A) Analyzing spatial/temporal human activity distribution to achieve multi-sector goals
(B) To randomly assign coastal land rights through a lottery system
(C) To plan the optimal routes for deep-sea underwater communication cables exclusively
(D) To map out the maximum possible area for unrestricted offshore oil drilling

2008
223. Consider the following ecological features characteristic of Ecologically Sensitive Areas (ESAs):
I. High vulnerability to human-induced disturbances.
II. Presence of monotypic, highly resilient invasive species.
III. Rich in biological diversity and endemism.
IV. Low conservation value and rapid recovery rates.
V. Often function as vital biological corridors.
Which of the above features are correct?
(A) I, III, and V
(B) II, IV, and V
(C) I, II, and III
(D) III, IV, and V

2024
224. Blue carbon sinks, such as mangroves and salt marshes, are considered more efficient at long-term carbon sequestration than terrestrial forests primarily due to:
(A) Vertical accretion of anoxic sediments preserving carbon without decomposition
(B) The faster photosynthetic rates of marine plants compared to terrestrial trees
(C) The complete absence of any herbivorous species in coastal ecosystems
(D) The chemical transformation of carbon directly into calcium carbonate by the plants

NODIA

2011

225. Which mangrove species is commonly known as the "apple mangrove" and possesses distinctive spherical fruits and lack of pronounced stilt roots or pneumatophores?
(A) Sonneratia alba
(B) Rhizophora mucronata
(C) Avicennia marina
(D) Xylocarpus granatum

2010

226. The "viviparous" reproduction in Rhizophora involves the hypocotyl emerging from the fruit while still attached to the parent tree. This structure is properly termed a:
(A) Propagule
(B) Spore
(C) Tuber
(D) Rhizome

2002

227. Fringing reefs and barrier reefs are distinguished primarily by the presence or absence of which geomorphological feature?
(A) A deep, navigable lagoon separating the reef from the adjacent shoreline
(B) A central, emergent volcanic island
(C) A steep, vertical fore-reef drop-off into the abyssal plain
(D) A distinct zone of back-reef patch corals

2003

228. The phenomenon of "fluorescence" in corals, where they emit bright, glowing colors under UV or blue light, is thought to serve primarily as:
(A) A photoprotective mechanism regulating the light environment for the zooxanthellae
(B) A mechanism to physically burn encroaching algae
(C) A lure to capture large pelagic fish
(D) A warning signal to deter apex predators like sharks

2013

229. Seagrasses reproduce primarily through which two mechanisms?
(A) Vegetative propagation via rhizome extension and sexual reproduction via submerged flowers and seeds
(B) Spore dispersal and binary fission
(C) Budding and fragmentation exclusively
(D) Aerial pollination and wind-dispersed seeds

2023

230. The community structure of infauna in a coastal mudflat is heavily regulated by "bioturbation". What is bioturbation?
(A) The physical mixing and oxygenation of sediments caused by the burrowing and feeding activities of benthic organisms
(B) The mechanical breakdown of organic matter by wave action
(C) The rapid die-off of benthic fauna due to sudden toxic algal blooms
(D) The settling of fine suspended sediments during slack tide

2012

231. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): Salt marshes exhibit distinct lower, middle, and upper marsh zones characterized by different plant species.
Reason (R): Plant species in salt marshes are distributed along a stress gradient, where lower marsh species are more tolerant of prolonged tidal flooding and anoxia, while upper marsh species are better competitors but less flood-tolerant.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2002

232. Which of the following is NOT a characteristic typically used to identify a "hydric soil" in a freshwater wetland?
(A) A strong smell of hydrogen sulfide (rotten egg odor)
(B) The presence of distinct redoximorphic features (mottling)
(C) A high concentration of highly oxidized, bright red iron compounds indicating continuous aeration
(D) A thick, dark surface layer of un-decomposed organic matter (peat or muck)

2002

233. During the nesting process, what is the primary function of the "egg chamber" dug by the female sea turtle?
(A) Creating a stable, insulated, and protected micro-environment for development

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(B) To provide a temporary resting spot for the female before she returns to the sea
(C) To serve as a trap to catch small crustaceans for the hatchlings to eat upon emerging
(D) To allow the eggs to be frequently washed and cooled by the incoming high tide

2024

234. The biomedical bleeding of horseshoe crabs involves extracting a portion of their hemolymph. Which specific cell type is targeted for the production of the LAL test?
(A) Amebocytes
(B) Erythrocytes
(C) Leukocytes
(D) Thrombocytes

2013

235. Consider the following events associated with severe coastal eutrophication:
I. Mass mortality of benthic fauna (dead zones).
II. Depletion of dissolved oxygen in bottom waters.
III. Excessive nutrient input (e.g., agricultural runoff).
IV. Rapid proliferation of phytoplankton (algal blooms).
V. Death and bacterial decomposition of algal biomass.
Which of the following represents the correct cascading sequence?
(A) III, IV, V, II, I
(B) III, V, IV, I, II
(C) IV, III, V, II, I
(D) III, IV, II, V, I

2011

236. How does global warming contribute directly to global sea-level rise affecting Ecologically Sensitive Areas?
(A) Thermal expansion of seawater and melting of land-based glaciers and ice sheets
(B) Exclusively through the melting of floating sea ice in the Arctic
(C) By increasing the total amount of rainfall over the open ocean
(D) By causing the tectonic subsidence of all global continental shelves simultaneously

2023

237. Which IUCN category is explicitly designated as a "Managed Resource Protected Area", focusing on the sustainable use of natural ecosystems?
(A) Category Ia
(B) Category II
(C) Category III
(D) Category VI

2003

238. In the context of a Biosphere Reserve, what is the primary function of the "Transition Area"?
(A) Balancing conservation with sustainable management and socio-economic development
(B) To strictly prohibit all human activity and act as an absolute wilderness
(C) To serve as an area of intensive, unregulated heavy industrialization to support the local economy
(D) To create a physical barricade preventing wildlife from escaping the core zone

2010

239. The Coastal Regulation Zone (CRZ) rules are issued under the powers conferred by which major overarching environmental legislation in India?
(A) The Environment (Protection) Act, 1986
(B) The Forest (Conservation) Act, 1980
(C) The Water (Prevention and Control of Pollution) Act, 1974
(D) The Biological Diversity Act, 2002

2010

240. The National Wetland Decadal Change Atlas of India is primarily generated using which advanced technological tool?
(A) Remote sensing using satellite imagery (e.g., from ISRO's RESOURCESAT) integrated with Geographic Information Systems (GIS)
(B) Traditional ground-truthing with measuring tapes exclusively
(C) Acoustic telemetry tracking of fish
(D) Deep-sea manned submersibles

NODIA

2009

241. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): The Wildlife (Protection) Act, 1972 completely excludes the protection of marine flora.
Reason (R): The Act is specifically designed only for the protection of wild animals, birds, and terrestrial plants, leaving marine flora unregulated.
(A) Both A and R are true and R is the correct explanation of A.

(D) Flooding the area permanently with fresh water to kill all remaining marine parasites

2008

288. The foundational premise of Integrated Coastal Zone Management (ICZM) is that:
(A) Coastal interconnectedness requires coordinated, holistic governance across sectors
(B) Economic development and environmental conservation are mutually exclusive concepts that cannot co-exist in coastal areas
(C) Coastal management should be left entirely to unregulated market forces and private developers
(D) Only the deep-sea marine environment requires management, while the intertidal zone is ecologically irrelevant

2018

289. Which coastal geomorphological feature provides natural protection against coastal erosion by continuously supplying sand to the beach profile during high-energy storm events?
(A) A well-vegetated coastal foredune system
(B) An expansive, concrete coastal promenade
(C) A deep, dredged navigational shipping channel
(D) An offshore, submerged oil pipeline

2012

290. Consider the following structural components of a classic coral reef:
I. Reef Flat
II. Fore-reef Slope
III. Reef Crest
IV. Back-reef Lagoon
Which of the following represents the correct geographical sequence moving from the open ocean landward towards the shoreline?
(A) II, III, I, IV
(B) I, II, III, IV
(C) III, II, I, IV
(D) IV, I, III, II

2002

291. Which specific factor represents the greatest imminent threat to the survival of small, low-lying coral atoll nations (e.g., Maldives, Tuvalu)?
(A) Sea-level rise leading to inundation and saltwater intrusion into aquifers
(B) A sudden, massive overpopulation of commercially valuable tuna
(C) The continuous, rapid tectonic uplift of the ocean floor pushing the atolls out of the water
(D) A dramatic decrease in global ocean temperatures causing the atolls to freeze

2016

292. Which of the following statements accurately describes the physiological mechanism of "vivipary" in mangroves?
(A) Propagules develop on the parent to draw nutrients and avoid osmotic stress
(B) It involves the plant exclusively reproducing asexually via broken root fragments floating in the tide.
(C) It describes the process where mangroves produce brightly colored, fleshy fruits to attract marine fish for pollination.
(D) It is a mechanism to completely halt reproduction during years of severe drought.

2003

293. The ecological phenomenon known as "coral bleaching" is visibly characterized by the reef turning stark white. What is the physical reason for this white appearance?
(A) Expulsion of pigmented zooxanthellae revealing the underlying white skeleton
(B) The coral polyps secrete a massive layer of white calcium carbonate over their living tissue to reflect sunlight
(C) A specific marine fungus completely covers the reef in a thick white mycelial mat
(D) The ocean water chemically bleaches the organic tissue, turning it instantly into white ash

2010

294. Seagrasses are considered true angiosperms. Which of the following structural adaptations is NOT typically found in seagrasses?
(A) Highly lignified, rigid trunks resembling terrestrial trees to withstand wave action
(B) Extensive rhizome and root systems for anchoring in soft substrates
(C) Internal aerenchyma tissue for buoyancy and gas transport
(D) Ribbon-like, flexible leaves to minimize drag in water currents

2001

295. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): The establishment of Marine Protected Areas (MPAs) solely for biodiversity

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(C) The complete absence of suitable hard substrates for larval settlement
(D) Extreme hypersalinity caused by low regional rainfall

2002

250. The symbiotic relationship between corals and zooxanthellae is highly sensitive to temperature stress. An increase in sea surface temperature of just 1-2 degrees Celsius above the normal summer maximum can trigger:
(A) Mass coral bleaching as corals expel zooxanthellae or algae lose pigments
(B) A massive increase in coral calcification rates
(C) The coral host rapidly consuming its zooxanthellae for energy
(D) The immediate transformation of the coral skeleton into dissolved calcium

2021

251. The primary ecological role of seagrass beds as a "nursery habitat" is attributed to:
(A) Canopy structural complexity providing refuge and abundant food resources
(B) Their ability to actively hunt and kill predators of juvenile fish
(C) The secretion of specific hormones into the water that accelerate the growth rate of all juvenile marine life
(D) Their location exclusively in deep, aphotic oceanic waters where predators are absent

2008

252. Epifauna on coastal mudflats generally exhibit which feeding strategy?
(A) Surface deposit feeding and grazing on the epipelic microalgal biofilms covering the mud surface
(B) Exclusively active predation on large pelagic fish
(C) Deep-sediment deposit feeding, never emerging to the surface
(D) Strict obligate parasitism on migratory shorebirds

2019

253. In salt marsh ecology, what is the primary mechanism by which the invasive species Spartina alterniflora outcompetes native marsh vegetation when introduced outside its native range?
(A) Superior tolerance to inundation, salinity, and anoxia with rapid lateral spread
(B) It produces highly toxic seeds that kill all surrounding native plants
(C) It grows to the height of large trees, completely shading out the marsh
(D) It actively lowers the salinity of the marsh, making it unsuitable for native halophytes

2023

254. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): Most freshwater wetlands act as sinks for heavy metals and other pollutants.
Reason (R): The physical slowing of water flow allows suspended sediments to settle, and the biogeochemical environment of hydric soils promotes the precipitation and binding of many pollutants.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2004

255. The "carapace" of a sea turtle refers to which specific anatomical structure?
(A) The dorsal, convex part of the shell structure
(B) The plastron (ventral shell)
(C) The specialized, paddle-like front flippers
(D) The horny beak used for feeding

NODIA

2010

256. Which statement accurately describes the feeding ecology of the horseshoe crab (Tachypleus gigas)?
(A) It is a benthic scavenger and predator, primarily feeding on marine worms, small mollusks, and crustaceans in the mud
(B) It is a strict, obligate filter feeder consuming only phytoplankton
(C) It is an apex predator that actively hunts adult marine fish in the water column
(D) It is entirely autotrophic, relying on a unique form of chemical synthesis

2014

257. Which anthropogenic activity is considered the primary driver of "coastal squeeze" for estuarine habitats like salt marshes and mangroves?
(A) Rigid coastal defenses combined with sea-level rise preventing landward migration
(B) The implementation of strict catch quotas for commercial fisheries
(C) The establishment of highly protected, no-

2011

272. Coral bleaching is fundamentally a breakdown of a symbiotic relationship. If the stressor (e.g., elevated temperature) is rapidly removed, what is the most likely outcome for a moderately bleached coral colony?

(A) Recovery by re-acquiring or multiplying residual zooxanthellae populations
(B) Immediate and irreversible death of the entire colony
(C) The coral permanently switches to a fully autotrophic lifestyle without zooxanthellae
(D) The coral instantaneously regrows a completely new calcium carbonate skeleton

2001

273. The global distribution of seagrasses is primarily limited by which critical physical parameter?

(A) Sufficient photosynthetically active radiation reaching the benthic substrate
(B) The concentration of dissolved oxygen in the anoxic sediment
(C) The presence of massive coral reef structures to provide necessary shading
(D) The absolute requirement for daily exposure to atmospheric air during low tide

2021

274. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:

Assertion (A): Coastal mudflats appear barren on the surface but possess extremely high biological productivity.

Reason (R): The productivity is driven by immense populations of epipelic microalgae and a highly efficient detrital food web supporting vast densities of infaunal invertebrates.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2010

275. Salt marsh ecosystems are most commonly found in which global geographic zones?

(A) Primarily in mid-to-high latitude temperate and sub-arctic coastal regions, replacing mangroves
(B) Exclusively along the equator in hypersaline lagoons
(C) Only in deep oceanic trenches devoid of light
(D) Exclusively in high-altitude inland saline lakes

2016

276. Which of the following is the most defining feature of "hydrophytic vegetation" used in wetland delineation?

(A) Plants that are adapted to life in water or in soil that is at least periodically deficient in oxygen as a result of excessive water content
(B) Plants that die immediately upon any contact with standing water
(C) Plants that possess massive, deep taproots to access deep aquifers in arid deserts
(D) Plants that exclusively parasitize other aquatic organisms

2018

277. The "arribada" nesting strategy of the Olive Ridley turtle is considered an evolutionary adaptation primarily designed to achieve:

(A) Predator satiation overwhelming predators to ensure high absolute survivors
(B) The physical flattening of the nesting beach for future generations
(C) The rapid depletion of local oxygen levels to deter predatory fish
(D) Maximum competition among hatchlings to ensure only the strongest survive

2015

278. The blood of the horseshoe crab contains amebocytes that are extraordinarily sensitive to:

(A) Lipopolysaccharide endotoxins found in Gram-negative bacterial membranes
(B) The venom of sea snakes
(C) Elevated levels of dissolved carbon dioxide
(D) The presence of microscopic plastic particles

2006

279. Which anthropogenic activity causes massive, localized "smothering" of benthic habitats like coral reefs and seagrass beds due to extreme sedimentation?

(A) Coastal capital dredging and irresponsible dumping of the dredge spoil
(B) Deep-water longline fishing
(C) Traditional hook-and-line artisanal fishing
(D) Regulated, seasonal recreational scuba diving

2008

280. How does the increasing concentration of atmospheric CO_2 lead directly to ocean acidification?

(A) Absorption of CO_2 forms carbonic acid,

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2014

264. The Convention on the Conservation of Migratory Species of Wild Animals (CMS) is also widely known as:
(A) The Bonn Convention
(B) The Basel Convention
(C) The Stockholm Convention
(D) The Rotterdam Convention

2010

265. What is the fundamental objective of using "Biorock" technology in coral reef ecological restoration?
(A) Electrolysis to accrete limestone substrate on frames, enhancing growth rates
(B) To introduce genetically modified, hyper-resilient artificial corals into the ecosystem
(C) To chemically dissolve excessive macroalgal growth on degraded reefs using targeted biocides
(D) To physically crush damaged coral rubble to create a smooth, flat sandy bottom

2022

266. Which action violates the core principles of Integrated Coastal Zone Management (ICZM)?
(A) Authorizing infrastructure based on sectoral goals without public consultation
(B) Establishing an inter-ministerial coordinating committee to review coastal development projects
(C) Conducting a comprehensive environmental and social impact assessment prior to approving a new coastal port
(D) Developing a spatial marine plan that designates specific zones for shipping, conservation, and traditional fishing

2019

267. Consider the following statements regarding the declaration of Eco-Sensitive Zones (ESZs):
I. The primary purpose is to create a "shock absorber" for protected areas.
II. All agricultural practices within an ESZ are immediately and permanently banned.
III. ESZs act as a transition zone from areas of high protection to areas involving lesser protection.
IV. The extent of an ESZ is strictly and uniformly 10 kilometers around all protected areas, without exception.
Which of the above statements are correct?
(A) I and III
(B) I, II, and IV
(C) II and III
(D) I, III, and IV

2025

268. Blue carbon stored in coastal ecosystems is considered highly vulnerable to remineralization and atmospheric release upon habitat destruction. This vulnerability is primarily because:
(A) Degradation exposes anoxic sediments to oxygen, triggering rapid decomposition
(B) The carbon is stored as a volatile gas in the plant stems
(C) Destroyed plants immediately spontaneously combust
(D) The carbon is held loosely in the surface leaves which instantly dissolve into the ocean

2006

269. The dominant mangrove genus Avicennia is commonly referred to by which vernacular name in many parts of the world?
(A) Black mangrove
(B) Red mangrove
(C) White mangrove
(D) Apple mangrove

2006

270. Consider the following true mangrove genera:
I. Bruguiera
II. Rhizophora
III. Heritiera
IV. Sonneratia
Which of the following represents the typical zonation sequence from the seaward (lowest intertidal) edge to the landward (highest intertidal) edge?
(A) IV, II, I, III
(B) II, IV, I, III
(C) IV, I, II, III
(D) III, I, II, IV

2006

271. Which characteristic represents a fundamental difference between ahermatypic corals and hermatypic corals?
(A) Ahermatypic corals generally do not possess symbiotic zooxanthellae and therefore do not construct massive biogenic reef frameworks
(B) Ahermatypic corals are exclusively found in freshwater
(C) Hermatypic corals are solitary organisms that never form colonies
(D) Hermatypic corals cannot secrete calcium carbonate under any circumstances

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entry Marine Protected Areas
(D) The promotion of sustainable, non-motorized ecotourism

2021

258. Which of the following statements is incorrect regarding the impact of climate change on coastal Ecologically Sensitive Areas?
I. Increased frequency and intensity of cyclonic storms can physically devastate coral reefs and mangrove forests.
II. Ocean acidification significantly enhances the growth rate and structural integrity of calcareous algae and hermatypic corals.
III. Sea-level rise can drown coastal wetlands if the rate of relative sea-level rise exceeds the rate of vertical sediment accretion.
IV. Elevated sea surface temperatures disrupt the synchrony of marine larval development and settlement.
Which of the above statements are incorrect?
(A) I and II
(B) II
(C) III and IV
(D) IV

2001

259. What is the fundamental requirement for a Marine Protected Area (MPA) to successfully protect highly mobile, migratory pelagic species?
(A) The MPA must be vast in scale, potentially spanning international boundaries, and form part of a connected network of protected critical habitats
(B) The MPA must be infinitesimally small to concentrate the species
(C) The MPA must be completely enclosed by an impenetrable physical net from the seafloor to the surface
(D) The MPA must only restrict recreational fishing while allowing unlimited commercial exploitation

2025

260. The core zone of a UNESCO Biosphere Reserve is specifically mandated to be:
(A) Legally established and strictly protected to ensure the long-term conservation of landscapes, ecosystems, species, and genetic variation
(B) A highly active site for experimental, destructive ecological research
(C) The primary residential area for all indigenous communities living within the reserve
(D) Subjected to rotational clear-cutting to maintain early successional habitats

2011

261. According to the Coastal Regulation Zone (CRZ) rules, what is the primary regulatory difference between CRZ-I A and CRZ-I B?
(A) CRZ-I A covers ecologically sensitive areas (like mangroves and corals), whereas CRZ-I B covers the intertidal zone between the Low Tide Line and High Tide Line
(B) CRZ-I A includes densely populated urban areas, while CRZ-I B includes rural villages
(C) CRZ-I A is meant for industrial development, while CRZ-I B is strictly for residential housing
(D) CRZ-I A refers to deep ocean waters, while CRZ-I B refers to inland freshwater rivers

2018

262. Under the Wetland (Conservation and Management) Rules, 2017, the term "wise use" is interpreted by the National Wetland Committee based on:
(A) Maintenance of the wetland's ecological character, achieved through implementation of an ecosystem approach
(B) Maximum short-term economic exploitation of wetland resources
(C) Complete and permanent exclusion of all human interaction with the wetland
(D) The conversion of wetlands into highly managed, artificial aquaculture ponds

NODIA

2009

263. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): The Wildlife (Protection) Act, 1972 is primarily designed to protect only terrestrial mammalian megafauna.
Reason (R): While originally focused on terrestrial animals, the Act has been repeatedly amended to include various marine species, including corals, sea cucumbers, marine turtles, and specific fishes, placing them under varying schedules of protection.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

releasing pH-lowering hydrogen ions
(B) CO_2 chemically reacts with atmospheric ozone, precipitating nitric acid into the ocean
(C) CO_2 dramatically increases the temperature of the ocean, which causes natural salts to become highly acidic
(D) Elevated CO_2 encourages the mass proliferation of acid-secreting deep-sea bacteria

2007
281. An IUCN Category Ia Marine Protected Area (Strict Nature Reserve) is distinct from a Category II MPA (National Park) primarily because:
(A) Category Ia is for scientific research with restricted access; Category II allows managed visitation
(B) Category Ia allows industrial commercial fishing, whereas Category II bans it completely
(C) Category Ia is exclusively terrestrial, whereas Category II is exclusively marine
(D) Category Ia permits extensive oil drilling, whereas Category II only allows natural gas extraction

2025
282. The Gulf of Mannar Biosphere Reserve is globally recognized primarily for its rich diversity of which associated coastal ecosystems?
(A) Highly integrated ecosystems of coral reefs, seagrass meadows, and mangrove forests supporting endangered species like the Dugong
(B) Only massive, monotypic stands of terrestrial pine forests
(C) Extensive, deep-sea hydrothermal vent communities
(D) High-altitude freshwater glacial lakes

2006
283. Under the provisions of the CRZ-2019 notification, the "High Tide Line" (HTL) is specifically demarcated by which designated national authority in India?
(A) The National Centre for Sustainable Coastal Management (NCSCM)
(B) The local village Panchayat
(C) The Indian Space Research Organisation (ISRO) independently
(D) The Central Pollution Control Board (CPCB)

2023
284. The regulatory framework of the Wetland (Conservation and Management) Rules specifically prohibits the conversion of wetland areas for which of the following uses?
(A) Non-wetland uses including encroachment of any kind, and setting up of any industry or expansion of existing industries
(B) Eco-friendly, low-impact bird watching trails
(C) The strictly regulated, traditional harvesting of lotus stems by local communities
(D) Routine scientific sampling of water quality parameters

2006
285. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). Select the correct answer from the options given below:
Assertion (A): All species of Scleractinian (hard) corals found in Indian territorial waters are strictly protected under the Wildlife (Protection) Act, 1972.
Reason (R): They are listed under Schedule I of the Act, which completely prohibits their extraction, trade, and commercial utilization, treating offenses with the highest penalties.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019
286. Which international convention provides a framework specifically for the conservation and wise use of wetlands and their resources?
(A) The Ramsar Convention
(B) The Stockholm Convention
(C) The Convention on International Trade in Endangered Species (CITES)
(D) The Minamata Convention

2013
287. Which technique represents the most ecologically sound approach to restoring a coastal area entirely denuded of its native mangrove cover due to historical aquaculture?
(A) Assessing and restoring hydrological conditions to allow for native recruitment
(B) Planting massive monocultures of the fastest-growing exotic tree species available
(C) Paving the area with concrete to prevent further soil erosion

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(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2003
242. The Convention on Biological Diversity (CBD) establishes the "Cartagena Protocol". What is the primary focus of this specific protocol?
(A) The safe transfer, handling, and use of Living Modified Organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biodiversity
(B) The immediate cessation of all international timber trade
(C) The regulation of greenhouse gas emissions from international shipping
(D) The establishment of massive no-take marine reserves in the high seas

2008
243. When undertaking ecological restoration of a damaged coastal area, what is the principle of "Adaptive Management"?
(A) Adjusting management strategies based on observed responses and new knowledge
(B) Sticking rigidly to the initial restoration plan regardless of negative outcomes
(C) Abandoning the project immediately if the first planting attempt fails
(D) Replacing all native species with highly resilient, non-native invasive species

2003
244. Integrated Coastal Zone Management (ICZM) differs fundamentally from traditional sectoral management because it:
(A) Coordinates policies across multiple sectors and administrative coastal boundaries
(B) Focuses exclusively on maximizing the economic output of the commercial fishing sector
(C) Manages different coastal activities (e.g., fisheries, tourism, shipping) in complete isolation from one another
(D) Transfers all coastal management responsibilities to international non-governmental organizations

2023
245. Consider the following coastal ecosystems/ ecotones:
I. Estuarine mudflats/Salt marshes
II. Open coastal waters / Fringing Coral Reef
III. Freshwater riverine wetlands
IV. Mangrove forest
Which of the following represents the typical sequence from high-energy offshore to inland freshwater environments along a tropical coast?
(A) II, IV, I, III
(B) II, I, IV, III
(C) IV, I, II, III
(D) I, II, IV, III

2014
246. What specific ecological boundary does an ecotone represent?
(A) A transition area between two adjacent but distinct ecosystems, often exhibiting characteristics of both and possessing unique species
(B) A zone of complete sterility separating two highly productive ecosystems
(C) A sharp, impermeable barrier preventing the movement of all species
(D) A theoretical line drawn on a map that has no physical or biological reality

2021
247. The term "true mangroves" refers strictly to:
(A) Intertidal specialists that play a major role in community structural density
(B) Any coastal plant capable of surviving a single exposure to saltwater
(C) All salt-tolerant terrestrial trees found within 10 km of the coast
(D) Exclusively the members of the family Rhizophoraceae

2025
248. The "knee roots" characteristic of Bruguiera species function primarily to:
(A) Provide structural support and facilitate oxygen exchange in anoxic environments
(B) Act as aggressive weapons to deter herbivorous crabs
(C) Store massive quantities of freshwater for the dry season
(D) Perform underwater photosynthesis during high tide

NODIA

2002
249. Which environmental parameter restricts the formation of extensive coral reefs on the western coasts of major continents (e.g., western South America or Africa)?
(A) Cold-water upwelling systems and cool boundary currents limiting thermal ranges
(B) Excessive levels of dissolved oxygen in the water

conservation often faces significant opposition from local artisanal fishing communities.
Reason (R): Strict no-take zones can immediately displace traditional fishers from their historical fishing grounds, causing severe short-term economic hardship and food insecurity if alternative livelihoods are not provided.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2009

296. Which physiological adaptation is crucial for the survival of pioneer psammophytes in a coastal sand dune environment?
(A) Rapid shoot elongation in response to burial and deep root systems for moisture
(B) The development of massive, water-logged pneumatophores
(C) The complete loss of all epidermal layers to maximize direct nutrient absorption from the air
(D) The permanent shedding of all root systems to remain highly mobile across the dune surface

2009

297. In the context of Ramsar sites in India, which specific wetland is renowned for its complex hydrology, fluctuating between a freshwater system during monsoons and a highly saline lagoon during the dry season?
(A) Chilika Lake
(B) Wular Lake
(C) Deepor Beel
(D) Harike Lake

2006

298. The sex-determining mechanism in marine turtles (TSD) is highly sensitive. At the "pivotal temperature", the resulting clutch of hatchlings will typically be:
(A) 100% male
(B) 100% female
(C) An approximately 1:1 ratio of males to females
(D) Entirely sterile

2006

299. Which of the following anthropogenic practices constitutes a severe, direct "destructive fishing practice" that physically annihilates complex benthic habitats?
(A) Using cyanide to stun fish while simultaneously poisoning surrounding polyps
(B) The establishment of strict catch-and-release quotas for sport fishing
(C) The use of specialized bycatch reduction devices (BRDs) in trawl nets
(D) The deployment of artificial fish aggregating devices (FADs) in the open pelagic ocean

2015

300. The concept of "Stakeholder Participation" is central to ICZM. Which group is essential to include to ensure the socio-economic sustainability and equitable enforcement of coastal management plans?
(A) Coastal communities, traditional fishers, industry representatives, and local government
(B) Only high-level central government bureaucrats
(C) Only international tourists visiting the coastal resorts
(D) Exclusively academic researchers from foreign universities

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ANSWERS

1. (B) To create a transition zone that minimizes the impact of human activities on the fragile ecosystem of the protected area
Eco-Sensitive Zones act as vital transition areas surrounding highly protected habitats to buffer fragile ecosystems from adjacent human activities. These regulatory zones mitigate the negative impacts of industrialization, development, and urbanization without completely prohibiting sustainable local livelihoods. They function as essential shock absorbers that maintain long-term ecological integrity across landscape boundaries.

2. (D) An increased species diversity and density due to the overlapping of adjacent community boundaries
The edge effect in transitional ecosystems represents the ecological phenomenon where species richness and population density increase at boundary interfaces. This occurs because the ecotone contains species from both adjacent habitats along with specialized organisms adapted to the transitional conditions. Consequently, resource availability and ecological niches are significantly elevated within these overlapping zones.

3. (A) True mangroves possess specialized morphological and physiological adaptations to the intertidal environment, whereas associates do not exclusively rely on this habitat
True mangroves are specialized trees restricted entirely to intertidal environments, exhibiting critical adaptations such as salt exclusion mechanisms and aerial roots. In contrast, mangrove associates are facultative halophytes that can survive in coastal regions but lack the specialized evolutionary traits necessary to thrive exclusively inside high-salinity, tidal inundation zones.

4. (C) Avicennia
Members of the genus Avicennia possess specialized evolutionary adaptations for surviving in highly saline, anaerobic coastal sediments. These include vertical pneumatophores with porous lenticels for gas exchange and salt glands on leaf surfaces for active excretion. Some species also exhibit viviparous or cryptoviviparous reproduction to ensure successful seedling establishment in unstable tidal environments.

5. (A) A ring-shaped reef system encircling a lagoon without a central landmass
Atolls are unique geomorphological structures characterized by ring-shaped coral reefs that encircle a central lagoon. Unlike fringing or barrier reefs, atolls do not have a prominent central landmass or island. They typically develop over geological timescales as coral grows upward around a slowly subsiding oceanic volcanic island that eventually disappears beneath the sea surface.

6. (D) Hermatypic corals host zooxanthellae for reef-building; ahermatypic corals lack them.
Hermatypic corals are structural reef builders that maintain an obligate mutualistic relationship with photosynthesizing dinoflagellates known as zooxanthellae, restricting them to shallow, sunlit waters. Conversely, ahermatypic corals lack these symbiotic algae, do not construct massive limestone frameworks, and can inhabit deep, cold, and dark oceanic zones by relying entirely on heterotrophic feeding.

NODIA

7. (A) Both A and R are true and R is the correct explanation of A.
Seagrass meadows represent exceptionally efficient global sinks for blue carbon due to their structural capabilities. These marine angiosperms actively capture carbon dioxide through high photosynthetic rates and store organic carbon within their extensive, decay-resistant root systems. The underlying waterlogged, anoxic sediments prevent rapid decomposition, preserving organic matter for millennia and mitigating climate change impacts.

8. (C) High substrate instability, salt spray, low nutrient availability, and desiccation
Pioneer psammophytic plants inhabiting coastal sand dunes are morphologically adapted to survive severe environmental pressures. They must withstand constant sand movement, high salinity from oceanic salt spray, nutrient-deficient substrates, and intense solar desiccation.

Adaptations such as extensive root systems, rapid elongation, and succulent, waxy leaves enable these specialized species to stabilize dunes effectively.

9. (D) Accumulation of compatible solutes like proline and glycine betaine in the cytoplasm
Halophytic plants in hypersaline salt marshes manage osmotic stress and maintain cellular turgor by synthesizing organic compatible solutes. Chemical compounds such as proline and glycine betaine accumulate inside the cytoplasm without disrupting cellular biochemistry. This physiological mechanism lowers the internal osmotic potential, allowing roots to continue extracting water from highly saline, low-water-potential soils.

10. (A) Shallow freshwater inundation leading to the formation of anaerobic hydric soils
Typical freshwater wetlands are characterized by shallow water inundation that persists long enough to create saturated, anaerobic conditions. This prolonged waterlogging restricts oxygen diffusion, causing microbial communities to deplete oxygen and form distinct hydric soils. These chemical conditions slow down the rate of organic matter decomposition, leading to characteristic sediment accumulation.

11. (B) Lepidochelys olivacea
The phenomenon of arribada refers to the spectacular mass synchronous nesting behavior exhibited by marine turtles, most notably the Olive Ridley species. During these events, tens of thousands of females gather in coastal waters and climb ashore simultaneously to nest. This reproductive strategy saturates local predators, ensuring higher survival rates for the eggs and emerging hatchlings.

12. (B) Their hemolymph yields amebocytes used to detect bacterial endotoxins via LAL tests
Horseshoe crabs possess immense biomedical significance because their copper-based blue hemolymph contains specialized cells called amebocytes. These cells produce a clotting lysate that coagulates immediately upon contact with minute quantities of Gram-negative bacterial endotoxins. This reaction forms the basis of the Limulus Amebocyte Lysate test, which is universally used to certify medical equipment safety.

13. (A) Construction of hard defenses preventing landward habitat migration during sea-level rise
Coastal squeeze occurs when highly sensitive intertidal habitats like salt marshes and mangroves are trapped between rising sea levels and immovable landward barriers. The construction of hard engineering defenses, such as seawalls and dikes, physically prevents these ecosystems from migrating inland. As a result, the intertidal zone is progressively compressed, leading to severe habitat loss.

14. (C) Expulsion of symbiotic zooxanthellae due to thermal stress on photosynthetic systems
Mass coral bleaching is primarily triggered by elevated sea surface temperatures associated with global climate change. Thermal stress disrupts the photosynthetic machinery of symbiotic zooxanthellae inside the coral polyps, causing them to produce toxic oxygen radicals. In response, the coral host expels the algae, losing its vibrant pigments and exposing the white calcium carbonate skeleton beneath.

15. (A) P-2, Q-1, R-4, S-3
The International Union for Conservation of Nature establishes a standardized categorization system for marine protected areas. Under this framework, Category Ia designates strictly protected nature reserves dedicated to scientific research. Category II represents national parks protecting large-scale ecological processes. Category III focuses on protecting unique natural monuments, while Category VI permits the sustainable use of natural resources.

16. (C) The transition area
Within the zonation framework of a UNESCO Man and the Biosphere Reserve, the transition area is the outermost zone. This region is specifically designed to foster ecologically sustainable human activities, collaborative scientific research, and traditional resource use. It serves as a zone of cooperation where local communities, researchers, and managers work together to balance economic development with conservation.

17. (B) CRZ-I
Under India's Coastal Regulation Zone notification, the most ecologically sensitive coastal regions are classified as CRZ-I. This category encompasses critical ecosystems such as mangrove forests, coral reefs, turtle nesting

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beaches, and sand dunes. To preserve their ecological integrity, strict regulatory guidelines are enforced, and almost all forms of major industrial development or construction are prohibited.

18. (D) The Ramsar Convention
The wise-use concept is the foundational principle of the Ramsar Convention on Wetlands of International Importance. This framework defines wise use as the maintenance of the ecological character of wetlands through the implementation of ecosystem approaches within the context of sustainable development. India's national wetland conservation rules directly adopt this international standard to guide local wetland management.

19. (A) Schedule I
Under the Wildlife Protection Act of India, all species of marine turtles inhabiting national waters are granted the highest tier of legal protection by listing under Schedule I. This designation strictly prohibits hunting, capturing, or trading these endangered reptiles and their derivative products. Any legal violations incur severe criminal penalties, including mandatory imprisonment and heavy fines.

20. (C) CITES
The Convention on International Trade in Endangered Species of Wild Fauna and Flora is the primary international treaty regulating cross-border trade of threatened wildlife. Scleractinian corals and marine turtles are listed under its appendices to prevent commercial over-exploitation. Non-commercial trade of these specimens requires strict permitting and scientific findings that export will not harm wild populations.

21. (A) Tidal flushing regulates salinity and facilitates natural propagule dispersal
Restoring natural tidal hydrology is a fundamental first step in successful mangrove afforestation projects. Regular tidal flushing is critical because it regulates soil salinity levels, prevents toxic chemical accumulation, and oxygenates the sediment. Additionally, natural water movement transports and deposits native propagules, facilitating passive ecological recruitment and accelerating the overall recovery of the degraded habitat.

22. (D) A holistic approach integrating land-sea interactions and multiple stakeholder interests
Integrated Coastal Zone Management operates on the core principle of a holistic, multi-sectoral approach to governance. It actively addresses the complex physical and biological interactions between land and sea environments. By incorporating multiple stakeholder interests, including conservationists, local fishers, and tourism developers, this framework aims to balance economic progress with long-term ecological sustainability.

23. (B) Endemism, richness, unique geomorphology, and vulnerability to human threats
The Ministry of Environment, Forest and Climate Change identifies and notifies Ecologically Sensitive Areas based on specific ecological and geomorphological parameters. Key criteria include high levels of species richness, presence of endemic or endangered taxa, unique geomorphology, and high vulnerability to human disturbance. These notifications regulate damaging industrial activities while allowing compatible traditional practices.

24. (C) Capture and storage of atmospheric carbon by mangroves and seagrasses
Blue carbon sequestration represents the biological capture and long-term storage of atmospheric carbon dioxide by coastal and marine ecosystems. In estuarine ecotones, highly productive habitats like mangrove forests and seagrass meadows actively trap organic carbon within their dense biomass. The waterlogged, anoxic sediments beneath these plants prevent decomposition, storing carbon securely for centuries to millennia.

NODIA

25. (A) I, III, and V
True mangroves are restricted to tropical and subtropical latitudes where they exhibit distinct tidal zonation patterns. Rhizophora species typically dominate the lower intertidal zones because their stilt roots withstand strong wave energy. Meanwhile, Avicennia species are commonly situated in mid-to-high intertidal zones, relying on extensive networks of vertical pneumatophores to absorb atmospheric oxygen during low tide.

26. (A) The root endodermis via ultrafiltration
In many true mangrove species, salt exclusion is a primary physiological mechanism to tolerate

high salinity. This process occurs at the root level, specifically within the endodermis, where a highly selective ultrafiltration system blocks the entry of sodium and chloride ions. The plant actively absorbs water molecules while excluding up to ninety-nine percent of dissolved sea salts.

27. (B) Clear, warm water, shallow depth, and stable salinity
Hermatypic reef-building corals have highly specific oceanographic requirements to thrive and build limestone frameworks. They require clear, shallow water to allow maximum solar penetration for the photosynthetic needs of their symbiotic zooxanthellae. Optimal growth also depends on warm water temperatures, stable marine salinity levels, and low turbidity to prevent the smothering of coral polyps by sediment.

28. (B) The coral host receives fixed nitrogen while providing a calcium skeleton for algae to eat
The mutualistic relationship between corals and zooxanthellae involves a complex exchange of nutrients. The symbiotic dinoflagellates reside inside the coral's endodermal cells, where they photosynthesize and translocate organic compounds like glycerol, glucose, and amino acids to the host. In return, the coral provides metabolic waste products, such as carbon dioxide and ammonium, along with physical protection.

29. (A) True angiosperms that possess roots, rhizomes, and leaves, and can reproduce via submerged pollination
Seagrasses are unique marine macrophytes because they are true flowering vascular plants, or angiosperms, rather than macroalgae. They possess specialized internal structures including true roots, subterranean rhizomes, and flexible leaves. Remarkably, they have evolved the physiological ability to complete their entire life cycle, including underwater pollination and seed germination, completely submerged in saline environments.

30. (C) Infaunal invertebrate biomass supported by detrital food webs
Although coastal mudflats appear barren at first glance, they are incredibly productive habitats that support large populations of migratory wading birds. This high productivity is driven by immense biomasses of infaunal invertebrates, such as polychaetes, bivalves, and small crustaceans. These organisms thrive on abundant detritus and microscopic benthic algal biofilms, forming a rich trophic resource base.

31. (D) Tolerance to prolonged flooding, tidal energy, and associated soil anoxia
In salt marsh ecosystems, the lower boundary of Spartina species is primarily determined by physical tolerances. Plants growing at lower elevations must withstand prolonged periods of tidal inundation, high wave energy, and severe soil anoxia. Specialized metabolic adaptations and internal gas transport mechanisms enable these halophytes to survive these harsh waterlogged conditions where other plants fail.

32. (C) Saturation creating anaerobic conditions and organic matter accumulation
Hydric soils in freshwater wetlands are defined by prolonged water saturation, which restricts atmospheric oxygen diffusion into the soil profile. This waterlogged state rapidly depletes dissolved oxygen, creating anaerobic, reducing conditions. These chemical properties suppress aerobic microbial decomposition, leading to the characteristic accumulation of un-decomposed organic matter and the development of distinct grey or mottled colors.

33. (B) Higher incubation temperatures generally produce a higher proportion of female hatchlings
Marine turtles exhibit temperature-dependent sex determination, meaning the incubation temperature of the nest during the middle third of development dictates the sex of the hatchlings. Higher sand temperatures within the nest chamber produce a greater proportion of female offspring, whereas cooler temperatures yield males. Rising global temperatures pose a severe threat by skewing population sex ratios.

34. (D) Bottom trawling and dredging
Bottom trawling and dredging represent highly destructive anthropogenic activities that cause extensive mechanical damage to benthic marine ecosystems. These fishing methods involve dragging heavy, weighted nets and metal frames across the ocean floor. This action physically pulverizes structural coral reef frameworks, tears up extensive seagrass root networks, and decimates critical, slow-growing bottom-dwelling communities.

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subsiding volcanic island, which eventually sinks completely beneath the surface of the ocean.

71. (C) Mutualism
The ecological relationship between hermatypic corals and zooxanthellae is a classic example of obligate mutualism. The photosynthesizing dinoflagellates reside inside the coral's endodermal tissues, providing the host with organic compounds that supply up to ninety percent of its energy needs. In return, the coral polyp provides the algae with metabolic wastes and shelter.

72. (A) Extensive aerenchyma tissue facilitating internal gas transport to roots
Seagrasses survive completely submerged in marine environments due to critical structural adaptations. They possess extensive internal networks of interconnected gas-filled channels known as aerenchyma tissue. This specialized tissue facilitates the rapid transport of oxygen produced during leaf photosynthesis down to the roots buried in anaerobic sediment, ensuring continuous cellular respiration and metabolic function.

73. (A) Low-energy tidal currents promoting the deposition of fine silts, clays, and organic matter
Sediment dynamics in coastal mudflats are primarily governed by low-energy tidal environments. Gentle tidal flows allow fine suspended sediments, such as silts, clays, and organic detritus, to settle out of the water column and accumulate. This constant accretion of fine-grained particles creates the highly nutrient-rich, soft substrate characteristic of productive estuarine mudflats.

74. (A) Both A and R are true and R is the correct explanation of A.
Salt marsh ecosystems exhibit exceptionally high primary productivity but relatively low overall plant species richness. This occurs because the intertidal marsh environment is highly stressful, characterized by extreme salinity fluctuations and prolonged anoxic waterlogging. Only a few specialized halophytic plant species have evolved the advanced physiological adaptations required to survive and dominate these conditions.

75. (C) It is entirely man-made and completely devoid of any natural ecological functions.
Designated Ramsar wetlands must meet strict ecological criteria demonstrating international importance. Key indicators include supporting threatened or endangered species, regularly hosting twenty thousand or more waterbirds, or serving as critical spawning grounds and nursery areas for fish. Completely artificial sites devoid of any natural ecological functions do not qualify for Ramsar designation.

76. (A) Predator satiation ensuring higher survival for eggs and hatchlings
The synchronous nesting strategy of Olive Ridley turtles during the arribada is an evolutionary adaptation designed to achieve predator satiation. By emerging in tens of thousands over a few nights, the turtles overwhelm local predators with an abundance of food. Consequently, the proportion of eggs and hatchlings consumed is minimized, maximizing reproductive success.

77. (B) The full moon and new moon spring tides
The spawning ecology of the horseshoe crab along the Indian coast is highly synchronized with lunar cycles. Spawning events occur predominantly during full moon and new moon spring tides. This timing allows the crabs to deposit their eggs high up on the sandy beaches, protecting the nests from daily tidal washing and optimizing embryonic development.

78. (B) Pulverizing coral framework and killing non-target organisms via shock waves
Blast fishing represents an exceptionally destructive practice that causes catastrophic damage to marine ecosystems. The detonation of underwater explosives creates intense shock waves that physically pulverize structural coral frameworks, destroying centuries of reef growth. Additionally, the blast indiscriminately kills non-target organisms and juvenile fish, decimating local biodiversity and collapsing the benthic food web.

79. (A) Significant decrease in the availability of carbonate ions in seawater
Ocean acidification poses a major threat to marine calcifiers by altering the chemistry of the marine carbonate system. As the ocean absorbs excess carbon dioxide, it releases hydrogen ions that bind with available carbonate ions to form bicarbonate. This chemical shift drastically

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transparent engagement to ensure equitable distribution of space, resources, and coastal livelihoods.

44. (B) An ESZ acts as a regulatory buffer; a National Park strictly prohibits unauthorized exploitation
Under Indian environmental legislation, National Parks are highly protected areas where commercial exploitation of resources is strictly prohibited. Conversely, Eco-Sensitive Zones are designated as transition buffers surrounding these core reserves. They do not completely ban human activities but regulate specific commercial industries, such as mining and pollution, to shield the adjacent national park from environmental degradation.

45. (A) Mixing and riverine input drive localized nutrient retention and high cycling
Nutrient cycling in transitional aquatic ecosystems like estuaries is highly dynamic compared to the open ocean. Constant tidal mixing combined with riverine freshwater inputs transports abundant nutrients into these shallow waters. Physical and biological trapping mechanisms retain these nutrients locally, fueling highly efficient, localized biogeochemical cycling that supports immense primary and secondary estuarine productivity.

46. (A) I and III
The Sundarbans delta is recognized as the largest contiguous mangrove forest on Earth, serving as a critical global biodiversity hotspot. Within these ecosystems, Sonneratia and Bruguiera are classified as true mangrove genera due to their obligate intertidal specialization. Mangrove associates, however, lack advanced adaptations, and India accounts for only a small fraction of global cover.

47. (A) Allow embryos to develop on the parent to avoid initial osmotic stress
Vivipary is a remarkable evolutionary adaptation where seeds germinate and develop into functional seedlings while still physically attached to the parent mangrove tree. This continuous developmental pathway allows the young embryo to receive water and nutrients directly from the parent, bypassing the extreme osmotic stress, salinity, and unstable sediment conditions of the surrounding intertidal habitat.

48. (C) Fringing reefs
The extensive coral reefs surrounding the Andaman and Nicobar Islands are predominantly classified geomorphologically as fringing reefs. These structures grow directly adjacent to the shorelines of the islands, stretching along the coast without being separated by wide, deep channels. They provide critical coastal protection and support immense marine biodiversity within the island ecosystem.

49. (D) Aragonite
Hermatypic corals construct their robust calcareous frameworks through the active process of biogenic calcification. During this process, coral polyps precipitate dissolved calcium and carbonate ions into a solid mineral structure. This deposition occurs specifically in the form of aragonite, a highly crystalline polymorph of calcium carbonate that provides the structural integrity of reefs.

50. (A) Leaf canopies provide refuge and support abundant epibenthic food sources
Seagrass beds function as highly critical nursery grounds for diverse marine fishes and invertebrates. The dense structural complexity of the seagrass leaf canopy physically slows water currents and provides excellent shelter from larger predators. Additionally, the leaves support diverse epiphytic algae and associated epibenthic invertebrates, offering abundant food resources for developing juveniles.

51. (A) The lack of stable, hard attachment surfaces limits the settlement of sessile organisms
Epifaunal communities on coastal mudflats generally exhibit lower structural complexity than those on rocky intertidal shores. This limitation occurs because the fine, shifting muddy sediment lacks stable, hard substrates required for the attachment of sessile organisms like barnacles and mussels. Consequently, the benthic community is dominated by highly mobile epifauna and burrowing infauna.

52. (C) Salicornia europaea
Salicornia europaea is a highly specialized halophyte widely recognized as a pioneer species in salt marsh ecological succession. This annual plant possesses extreme salt tolerance and can colonize bare, highly saline mudflats. Its growth physically traps suspended sediments and stabilizes the substrate, gradually elevating the

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Furthermore, they help reduce human-wildlife conflicts near boundaries without requiring the eviction of indigenous populations or creating completely sterile zones.

89. (A) The Edge effect
Ecotones often support a higher density and diversity of organisms than adjacent habitats, a phenomenon known as the edge effect. This ecological trend occurs because the transitional boundary zone blends physical and biological characteristics of both neighboring communities. The overlap of resources and niches supports both generalist and highly specialized edge species.

90. (A) Rhizophora
The genus Rhizophora is globally recognized as the most widespread group of true mangroves, commonly referred to as red mangroves. These specialized trees are ecologically dominant in the lower intertidal zones of tropical coastlines. They are distinguished by their robust stilt root systems and prominent viviparous propagules adapted to unstable sediments.

91. (B) On the epidermal surface of the leaves
To manage internal salinity, several true mangrove species possess specialized anatomical adaptations known as salt glands. These glands are typically located on the epidermal surface of the leaves. They actively transport excess sodium and chloride ions out of the plant tissues, depositing visible salt crystals that are subsequently washed away by rain.

92. (A) I and IV
Coral reef systems are geomorphologically classified into distinct categories based on their relationship to land. Fringing reefs grow directly adjacent to the shoreline without a separating lagoon, whereas barrier reefs run parallel to the shore separated by deep channels. Atolls form ring shapes atop submerged volcanic structures, which does not apply to the Great Barrier Reef.

93. (B) Dinoflagellates (Dinophyceae)
Zooxanthellae are single-celled, photosynthetic organisms belonging to the taxonomic group of dinoflagellates. They form critical mutualistic relationships with diverse marine invertebrates, most notably scleractinian reef-building corals. By residing within the endodermal tissues of the coral host, these microalgae photosynthesize and provide essential organic carbon molecules that fuel reef calcification.

94. (A) Elongated, thread-like structures that rely on water currents for pollination
Seagrasses are unique marine angiosperms that have evolved specialized adaptations for submerged sexual reproduction. Their pollen grains are structurally modified into elongated, thread-like filaments rather than spherical structures. This shape maximizes buoyancy and surface area, allowing the pollen to drift on water currents and easily entangle with female stigmas.

95. (A) Epipelic benthic diatoms and cyanobacteria forming microscopic biofilms
Although coastal mudflats lack large structural vegetation, they are highly productive ecosystems. The dominant primary producers are microscopic epipelic benthic diatoms and cyanobacteria that form extensive biofilms over the mud surface. These microbial mats actively photosynthesize during low tide, stabilizing the sediment and providing the fundamental trophic resource for deposit-feeding invertebrates.

96. (A) Compartmentalization of sodium ions into large cellular vacuoles
Salt marsh halophytes employ advanced physiological adaptations to prevent toxic sodium accumulation within the cell cytoplasm. A primary mechanism involves the active compartmentalization of sodium ions into large cellular vacuoles. This sequestration keeps sodium away from sensitive metabolic enzymes in the cytoplasm, maintaining cell turgor and allowing water absorption from hypersaline soils.

97. (A) Both A and R are true and R is the correct explanation of A.
The construction of upstream dams severely degrades downstream estuarine wetlands by altering natural hydrology. Dams trap suspended sediments, drastically reducing the sediment delivery needed for vertical wetland accretion. Without this continuous sediment input, estuarine wetlands cannot maintain their elevation relative to rising sea levels, leading to widespread habitat loss and drowning.

98. (A) The ambient temperature of the sand during the middle third of the incubation period
The sex of marine turtle embryos is dictated by temperature-dependent sex determination. This

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identify, map, and formally recommend wetlands within their state boundaries for official notification. This decentralized governance ensures that local ecological characteristics and stakeholder interests are integrated into conservation planning.

62. (B) Schedule I
Under the Wildlife Protection Act of India, all species of hard corals belonging to the order Scleractinia are afforded the highest level of legal protection by being listed under Schedule I. This classification makes any extraction, damage, or commercial trade of hard corals a severe criminal offense, carrying heavy mandatory prison sentences and substantial fines.

63. (A) P-2, Q-1, R-4, S-3
International treaties address distinct aspects of global environmental governance. The Ramsar Convention focuses specifically on wetland conservation. The Convention on International Trade in Endangered Species regulates wildlife trade. The Convention on Biological Diversity promotes the sustainable use of biological resources, while the United Nations Framework Convention on Climate Change coordinates global greenhouse gas mitigation efforts.

64. (A) Structural complexity facilitating benthic settlement and attracting fish
The deployment of artificial reefs is a highly effective ecological restoration technique in degraded nearshore waters. These structures provide complex three-dimensional habitats that mimic natural rocky substrates. This structural complexity facilitates the settlement of sessile benthic organisms, offers critical shelter from predators, and attracts diverse fish species, ultimately enhancing local biodiversity and fisheries productivity.

65. (B) Balance conservation with sustainable development via participatory governance
The success of Integrated Coastal Zone Management programs is fundamentally measured by their ability to harmonize ecological conservation with socio-economic development. This objective is achieved through participatory governance frameworks that actively involve diverse stakeholders, ensuring that management decisions are equitable, scientifically sound, and capable of maintaining coastal ecosystem services over the long term.

66. (A) I, III, and V
Eco-Sensitive Zones are identified based on highly specific ecological, biological, and geomorphological criteria. Primary considerations include high degrees of species endemism, the presence of critical wildlife corridors that link fragmented habitats, and unique geomorphological features. Activities within these zones are regulated to shield adjacent protected areas from destructive external developmental pressures.

67. (A) Anaerobic conditions in sediments slow the decomposition of organic matter
Blue carbon sequestration is highly efficient within estuarine ecotones due to unique biogeochemical conditions. The constant waterlogging of estuarine sediments restricts atmospheric oxygen penetration, creating highly anaerobic soils. This absence of oxygen significantly slows down the rate of microbial decomposition, allowing organic carbon trapped by vegetation to remain buried and preserved for thousands of years.

68. (B) Lenticels
The vertical pneumatophores of Avicennia species possess specialized porous structural adaptations called lenticels on their bark. During low tide when the roots are exposed to the atmosphere, these structures facilitate vital gas exchange. They allow oxygen to diffuse directly into the internal aerenchyma tissue, supplying the submerged root system in the highly anaerobic sediment.

69. (A) Ultrafiltration in root membranes prevents salt entry via exclusion
Rhizophora species employ a highly efficient salt-excluding osmoregulatory strategy to survive in saline intertidal zones. This process depends on a specialized ultrafiltration system located within the endodermal cell membranes of the roots. This physical and chemical barrier actively blocks the uptake of sodium and chloride ions while allowing water molecules to enter the vascular system.

70. (D) Atoll
Atolls are distinct geomorphological structures formed by ring-shaped coral reefs that enclose a deep central lagoon. Unlike fringing or barrier reefs, atolls completely lack any central volcanic landmass or island. They develop over geological timescales as a reef grows upward around a

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35. (A) II and V
Ocean acidification is driven by elevated atmospheric carbon dioxide dissolving into seawater, which lowers ocean pH levels. This chemical shift decreases the concentration of carbonate ions, which directly impairs biogenic calcification in corals and calcareous macroalgae rather than enhancing it. It weakens the structural framework of existing reefs, accelerating rates of mechanical and biological erosion.

36. (C) Gahirmatha Marine Sanctuary
Gahirmatha Marine Sanctuary, located along the coast of Odisha, is globally renowned as the most significant nesting site for Olive Ridley marine turtles. Every winter, hundreds of thousands of nesting females gather here for the spectacular synchronous nesting event known as the arribada. Strict conservation regulations protect this critical shoreline habitat from harmful human disturbances.

37. (A) Host activities compatible with sound ecological practices
The buffer zone of a Biosphere Reserve is established directly adjacent to or surrounding the core protected area. Its primary ecological function is to host cooperative activities that are compatible with sound environmental conservation practices. These include managed scientific research, educational programs, low-impact ecotourism, and sustainable traditional resource use that do not compromise core biodiversity values.

38. (D) The line reached by the highest astronomical tide using physical markers
Under coastal regulation guidelines, the High Tide Line is defined as the line on the land reached by the highest astronomical tide. It is determined through scientific mapping that incorporates physical indicators, such as the deposition of debris, beach morphology, and presence of specific halophytic vegetation. This line acts as a regulatory baseline for coastal development zones.

39. (B) Solid waste dumping and discharge of untreated industrial effluents into the wetland
India's wetland protection rules strictly prohibit activities that severely degrade the ecological character of notified wetlands. Expressly banned actions include the dumping of municipal solid waste, land reclamation, and the direct discharge of untreated industrial or domestic effluents. These regulations aim to prevent severe eutrophication, toxic chemical pollution, and physical destruction of these fragile aquatic habitats.

40. (B) Their hunting and trade are strictly regulated, requiring specific permissions from the Chief Wildlife Warden
The inclusion of horseshoe crabs under Schedule IV of India's Wildlife Protection Act ensures that their harvesting, capture, and trade are highly restricted. Any utilization of these ancient marine arthropods, including for crucial biomedical research and testing, requires explicit statutory permissions from the state Chief Wildlife Warden. This regulatory oversight prevents unsustainable exploitation of wild populations.

41. (D) The complete privatization of all marine genetic resources
The Convention on Biological Diversity is built upon three primary, globally recognized goals. These objectives encompass the conservation of biological diversity, the sustainable use of its biological components, and the fair and equitable sharing of benefits arising from the utilization of genetic resources. Complete privatization of genetic resources directly contradicts these international treaty principles.

42. (A) Growing fragments in nurseries for later outplanting to degraded sites
Coral gardening is a highly effective, active ecological restoration technique modeled after terrestrial silviculture. The process involves collecting small coral fragments, growing them in sheltered mid-water or land-based nurseries where conditions are optimized for survival, and subsequently outplanting the mature colonies onto degraded reef substrates. This method significantly enhances local coral cover and structural complexity.

43. (B) Prioritizing tourism developers over fishing communities without consultation
Integrated Coastal Zone Management relies on participatory governance and multi-stakeholder spatial planning to resolve conflicts over coastal resource use. Prioritizing commercial tourism developers over traditional fishing communities without any consultation represents a failure of these core principles. Effective planning requires

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reduces the availability of carbonate ions, hindering corals from building calcium carbonate skeletons.

80. (B) Protect biodiversity and strictly limit human use to preserve natural ecological processes.
The core zone of an IUCN Category Ia Marine Protected Area is established to conserve exceptional biodiversity. Human activities within these strictly managed reserves are limited to non-destructive scientific monitoring and research. This absolute protection ensures that natural ecological processes remain undisturbed, providing critical reference sites for understanding long-term environmental changes.

81. (A) The buffer zone adjoins the core and is surrounded by the transition area
The UNESCO Man and the Biosphere framework utilizes a concentric spatial zonation design to manage protected landscapes. The strictly protected core zone is directly adjoined and encircled by the buffer zone, where compatible ecological activities are permitted. The outermost layer is the transition area, which integrates sustainable development and cooperative resource management.

82. (A) It is defined by the line marking the lowest point reached by the water during the lowest astronomical tide
For coastal regulation mapping, the Low Tide Line is scientifically defined as the line representing the lowest astronomical tide. This boundary marks the maximum exposure of the intertidal zone during extreme low tides. Accurately mapping this line is critical for establishing jurisdictional boundaries and regulating activities within the intertidal zone.

83. (C) River channels explicitly and man-made agricultural tanks
India's Wetland Conservation Rules define notified water bodies but explicitly exclude specific categories from their regulatory scope. Excluded areas include active river channels, commercial paddy fields, and man-made tanks constructed specifically for irrigation or drinking water. This distinction ensures that essential agricultural and infrastructural water uses are governed by appropriate separate legal frameworks.

84. (A) P-1, Q-2, R-3, S-4
India's Wildlife Protection Act categorizes species based on conservation threats. Endangered marine mammals like Dugongs, leatherback sea turtles, and all scleractinian hard corals are listed under Schedule I to receive absolute legal protection. Conversely, horseshoe crabs, which face moderate harvesting pressures, are listed under Schedule IV to regulate their capture, trade, and commercial use.

85. (A) The Jakarta Mandate on Marine and Coastal Biological Diversity
The implementation of the Convention on Biological Diversity within marine and coastal environments is structurally operationalized through the Jakarta Mandate. Adopted in 1995, this global program provides a comprehensive framework for sustainable marine resource use, integrated coastal management, protected area establishment, and the prevention of marine pollution and invasive species.

86. (A) Securely attaching coral fragments to stable substrates in good water quality
Successful coral transplantation protocols depend on key ecological and mechanical requirements. Coral fragments must be securely anchored to stable, hard substrates to prevent displacement by strong wave action and tidal currents. Additionally, selecting transplant sites with high water quality, minimal sedimentation, and adequate light penetration is critical to maximize long-term survival.

87. (A) Marine Spatial Planning (MSP) to allocate distinct zones and temporal periods for specific activities
Within the framework of Integrated Coastal Zone Management, conflicts between competing uses are resolved through Marine Spatial Planning. This planning process maps out coastal resources and human activities to allocate distinct geographical zones and temporal periods for specific sectors. This structured approach minimizes user conflicts and prevents ecological degradation from overlapping activities.

88. (A) I, II, and IV
The declaration of Eco-Sensitive Zones around protected areas is driven by critical conservation objectives. These zones act as shock absorbers to mitigate edge effects and regulate high-impact industrial activities like commercial mining.

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land surface and paving the way for other plant species.

53. (A) Transporting oxygen to submerged roots in anaerobic soil environments
Hydrophytes in freshwater wetlands possess specialized anatomical adaptations to survive in saturated, anaerobic substrates. The presence of highly developed aerenchyma tissue creates an internal network of interconnected gas channels. This structural pathway allows oxygen produced during photosynthesis or absorbed through leaves to diffuse rapidly down to the submerged roots, facilitating cellular respiration.

54. (A) Both A and R are true and R is the correct explanation of A.
Marine turtle populations are highly vulnerable to global warming due to temperature-dependent sex determination. As ambient sand temperatures during incubation rise above the pivotal threshold, the resulting hatchling sex ratio becomes extremely skewed toward females. This progressive reduction in male production severely threatens reproductive viability and genetic diversity, increasing the risk of population collapse.

55. (A) Amebocytes in the hemolymph rapidly coagulate in the presence of Gram-negative bacterial endotoxins
The Limulus Amebocyte Lysate test utilizes the specialized hemolymph of horseshoe crabs to detect bacterial contamination. This highly sensitive biomedical reaction depends on amebocytes, which release clotting factors that rapidly gel and coagulate when exposed to lipopolysaccharide endotoxins from Gram-negative bacteria. This diagnostic tool remains crucial for certifying the safety of injectable pharmaceuticals.

56. (D) Macroalgal proliferation and subsequent decomposition leading to hypoxic dead zone formation
Coastal eutrophication triggered by nutrient-rich runoff causes a series of severe ecological changes. The excess nitrogen and phosphorus stimulate the explosive growth of opportunistic macroalgae and phytoplankton. As this massive algal biomass dies and sinks to the bottom, aerobic bacteria decompose the organic matter, rapidly consuming dissolved oxygen and forming hypoxic dead zones.

57. (B) It induces shoreline erosion, saltwater intrusion, and prolonged flora inundation
Rising sea levels fundamentally alter sensitive coastal ecosystems through several physical mechanisms. It accelerates shoreline erosion, causing significant habitat loss for nesting turtles and shorebirds. Furthermore, it drives saltwater intrusion into coastal aquifers and freshwater wetlands, while subjecting intertidal flora to prolonged, deeper tidal inundation that can exceed their physiological flooding tolerance.

58. (B) Habitat diversity, life-cycle connectivity, and adequate spatial sizing
Establishing an effective Marine Protected Area network requires careful adherence to core ecological design principles. Priority must be placed on maximizing habitat diversity to protect multiple species assemblages. Additionally, ensuring biological connectivity between distinct ecosystems facilitates life-cycle migrations, while adequate spatial sizing ensures protected populations remain viable and resilient against external environmental threats.

59. (C) Dugong
The Gulf of Mannar Biosphere Reserve is a critical conservation area renowned for protecting the endangered marine mammal known as the Dugong. These herbivorous mammals are obligate seagrass specialists, relying entirely on extensive seagrass meadows for food. Protecting these habitats from destructive fishing and pollution is essential to prevent the extinction of this unique species.

60. (D) CRZ-IV encompasses the water areas from the Low Tide Line to 12 nautical miles seaward.
India's Coastal Regulation Zone notifications establish strict territorial boundaries for environmental management. CRZ-I encompasses highly sensitive ecosystems, while CRZ-II protects urban coastlines. CRZ-III regulates rural areas, and CRZ-IV specifically covers marine waters extending from the Low Tide Line out to twelve nautical miles, ensuring critical regulatory oversight over maritime pollution and developmental activities.

61. (C) The respective State Wetland Authority
Under the statutory framework of India's Wetland Rules, State Wetland Authorities hold primary institutional responsibility at the sub-national level. These bodies are mandated to

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biological process is governed by the average sand temperature surrounding the clutch during the critical middle third of the incubation phase. Even minor thermal shifts during this developmental window can heavily bias the sex ratio toward males or females.

99. (A) Bleeding results in significant post-release mortality and impacts on reproduction
The biomedical harvesting of horseshoe crab hemolymph is increasingly criticized for its negative ecological impacts. Studies indicate that the extraction process causes significant post-release mortality, alters behaviors, and impairs reproductive fitness. This decline in spawning crabs directly threatens shorebirds that rely on abundance of crab eggs during migration.

100. (A) Increased vulnerability of isolated subpopulations to local extinction events
Habitat fragmentation within coastal landscapes severely disrupts ecosystem continuity and connectivity. By dividing continuous habitats into small, isolated patches, fragmentation restricts species dispersal and genetic exchange. Consequently, small subpopulations become highly vulnerable to inbreeding depression, reduced adaptive capacity, and increased risk of local extinction from localized environmental disturbances.

101. (A) Bleaching mortality stops calcification, leaving reefs open to erosion
Rising sea surface temperatures compromise the structural integrity of coral reefs by driving mass bleaching events. When corals lose their symbiotic zooxanthellae, calcification ceases and the living tissue often dies. Without living coral cover to accrete calcium carbonate, the underlying limestone framework is rapidly degraded by mechanical wave energy and bioeroding organisms.

102. (A) National Parks protecting ecological processes while providing visitor opportunities
An IUCN Category II Marine Protected Area is designated as a National Park. Its primary management objective is to protect large-scale ecological processes and biodiversity. These areas are managed to preserve the natural state of the ecosystem while simultaneously providing opportunities for compatible spiritual, scientific, educational, and recreational visitor experiences.

103. (A) The UNESCO Man and the Biosphere (MAB) Programme
The global system of Biosphere Reserves was established under the UNESCO Man and the Biosphere Programme. Launched in 1971, this intergovernmental initiative aims to set a scientific basis for improving relationships between human populations and their environments. The program combines natural and social sciences to promote sustainable biodiversity conservation.

104. (A) CRZ-III
Under India's Coastal Regulation Zone guidelines, coastal areas that remain relatively undisturbed and do not fall under CRZ-I or CRZ-II are designated as CRZ-III. This category typically includes rural coastal zones where traditional agriculture and fisheries are practiced. Specific developmental activities and construction are strictly regulated to preserve coastal integrity.

105. (A) P-3, Q-4, R-1, S-2
Specialized structures and phenomena define specific marine taxa and habitats. True mangroves are characterized by respiratory pneumatophores. Hermatypic corals maintain mutualistic relationships with photosynthetic zooxanthellae. Biomedical amebocyte lysate tests are derived from horseshoe crabs, while arribada refers to the synchronized nesting events of marine turtles.

106. (A) Maintaining ecological character through ecosystem approaches in sustainable development
The wise-use principle of the Ramsar Convention advocates for the conservation and sustainable management of wetlands. This approach seeks to maintain the unique ecological character of these habitats through ecosystem-based strategies. It allows human use of wetlands as long as it remains sustainable and does not degrade biological diversity or hydrology.

107. (A) Tachypleus gigas
Tachypleus gigas is one of the dominant horseshoe crab species occurring along the eastern coast of India, particularly on the sandy mudflats of Odisha and West Bengal. This marine arthropod plays a vital role in coastal food webs and benthic ecosystems, relying on stable sandy beaches for nesting and spawning.

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rapidly within millimeters beneath the surface, creating a highly anaerobic, sulfide-rich zone. Burrowing organisms adapt structurally or physiologically to occupy distinct vertical layers based on oxygen tolerances.

164. (A) Both A and R are true and R is the correct explanation of A.
Salt marsh vegetation is highly effective at mitigating coastal erosion through physical interactions. The dense aboveground canopy of marsh grasses attenuates incoming wave energy and slows down tidal flows. Simultaneously, their extensive subterranean rhizome and root systems physically bind loose sediments together, increasing soil cohesion and preventing shoreline degradation.

165. (A) Marine/Coastal, Inland, and Human-made wetlands
The Ramsar Convention utilizes a standardized classification system that divides wetlands into three primary categories. These encompass Marine and Coastal wetlands, Inland wetlands, and Human-made wetlands. This comprehensive framework ensures that diverse aquatic habitats, from natural coral reefs and peatlands to artificial reservoirs and salt pans, are managed under appropriate conservation guidelines.

166. (A) Disorienting newly emerged hatchlings and leading them away from the sea
Artificial beach lighting severely impacts marine turtle reproduction by disrupting hatchling behavior. Emerging hatchlings naturally rely on low-intensity light cues reflected off the ocean horizon to guide them to the sea. Strong artificial lights disorient the hatchlings, drawing them inland where they face dehydration, predator consumption, and vehicular mortality.

167. (A) Righting itself when flipped onto its carapace by wave action
The long, rigid tail or telson of the horseshoe crab is a specialized morphological adaptation. Its primary ecological function is to help the animal right itself when flipped upside down by strong wave action on sandy beaches. The crab extends and anchors its telson in the sand to leverage its body back over.

168. (A) Conversion into commercial aquaculture ponds for shrimp farming
The global loss of mangrove forests over the past few decades is primarily driven by conversion into commercial aquaculture ponds, particularly for intensive shrimp farming. This industrial conversion clears extensive areas of native forest, alters natural tidal hydrology, and introduces high levels of nutrient pollution and chemical waste, causing long-term ecological degradation.

169. (A) Increasing water depth and reducing available radiation for photosynthesis
Sea-level rise driven by climate change threatens seagrass ecosystems primarily by increasing water column depth over benthic meadows. This deeper water reduces the amount of photosynthetically active radiation reaching the seafloor. Without adequate solar light, seagrasses cannot photosynthesize effectively, leading to reduced growth, meadow retreat, and localized die-offs.

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170. (A) Legal designation without effective management or financial resources
The term paper park refers to a Marine Protected Area that exists on official maps and legal documents but lacks active management, field enforcement, or adequate financial resources. Without active monitoring, patrolling, and community engagement, these protected areas fail to restrict destructive activities, leaving sensitive marine resources vulnerable to ongoing exploitation.

171. (A) It must be a legally protected site for conserving biological diversity, monitoring minimally disturbed ecosystems, and undertaking non-destructive research
The core area of a Biosphere Reserve must be legally established and strictly protected. Its primary purpose is to secure the long-term conservation of native biodiversity, monitor minimally disturbed ecosystems, and facilitate non-destructive scientific research. Human entry and resource extraction are strictly restricted to preserve natural ecological processes.

172. (C) 50 meters
Under the revised Coastal Regulation Zone notification guidelines, the No Development Zone for densely populated rural areas categorized as CRZ-III A is set at fifty meters from the High Tide Line. This regulatory limit aims to

Consequently, they can thrive in deep, cold, and dark oceanic environments, relying entirely on capturing zooplankton and organic matter to meet their nutritional needs.

118. (A) Rhizomes stabilize sediments and canopies slow currents to promote deposition
Seagrasses function as critical ecosystem engineers within coastal environments. Their extensive underground rhizome and root systems physically bind and stabilize loose sediments, reducing erosion. Simultaneously, their dense leaf canopies slow down tidal currents, which promotes the deposition of fine organic particles, improving water clarity and creating stable habitats for other marine life.

119. (A) To trap wind-blown sand, stabilize the foredune, and initiate primary succession
Pioneer psammophytic species like Spinifex littoreus play a crucial role in coastal sand dune ecology. Their sprawling growth form and specialized root systems trap wind-blown sand particles, physically stabilizing the shifting foredunes. By securing the substrate and introducing organic matter, these hardy plants initiate primary succession, allowing less tolerant plant species to establish.

120. (A) Physical stress gradients interacting with interspecific plant competition
The distinct zonation patterns in salt marshes are determined by the interaction of physical stressors and biological competition. Lower marsh zones are dominated by highly specialized halophytes capable of tolerating prolonged flooding and soil anoxia. Upper marsh zones, where physical stress is lower, are dominated by superior competitors that lack high flood tolerance.

121. (A) Saturated or flooded during the growing season to develop anaerobic conditions
In wetland classification, a hydric soil is defined by prolonged saturation or flooding during the growing season. This persistent waterlogging restricts the diffusion of atmospheric oxygen into the soil profile. Microbial activity rapidly consumes available dissolved oxygen, creating anaerobic conditions that influence the chemical characteristics and types of vegetation that can survive.

122. (A) Dermochelys coriacea
Dermochelys coriacea, commonly known as the leatherback turtle, is ecologically unique among marine turtles. It is characterized by a thick, leathery carapace made of tough connective tissue infused with tiny osteoderms, completely lacking hard bony scutes. This flexible structure allows the leatherback to dive to extreme depths without collapsing under hydrostatic pressure.

123. (A) Estuarine and mangrove-fringed muddy habitats with fluctuating salinities
Carcinoscorpius rotundicauda, the mangrove horseshoe crab, is ecologically distinct from other species. It is primarily found in estuarine and mangrove-fringed muddy habitats characterized by highly fluctuating salinities. This species has evolved high tolerance to brackish water conditions and relies on organic-rich, soft mud substrates for foraging and spawning.

124. (A) Benthic habitat removal and sediment resuspension causing high turbidity
Dredging in estuarine environments causes severe ecological damage to sensitive coastal ecosystems. The mechanical excavation physically removes benthic habitats, killing bottom-dwelling organisms. Additionally, dredging resuspends fine sediments into the water column, creating high turbidity that blocks sunlight, suffocates filter feeders, and releases trapped chemical pollutants back into the aquatic environment.

125. (A) I, II, and IV
Climate change impacts coastal ecosystems through multiple physical pathways. Ocean acidification hinders coral calcification, while sea-level rise threatens marine turtle nesting beaches. Furthermore, altered ocean currents disrupt the dispersal and recruitment of marine larvae. Elevated sea surface temperatures, however, drive extensive coral bleaching rather than preventing it, disrupting reef integrity.

126. (A) P-4, Q-2, R-3, S-1
India's marine protected areas are distributed across distinct coastal states. The Gulf of Kutch Marine National Park is situated in Gujarat. The Gulf of Mannar Marine National Park lies in Tamil Nadu. Gahirmatha Marine Sanctuary is located in Odisha, while the Mahatma Gandhi Marine National Park is situated in the Andaman and Nicobar Islands.

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145. (A) II, III, and V
Horseshoe crabs are ancient chelicerate arthropods rather than true decapod crustaceans. They possess blue, copper-based hemolymph and a long, rigid tail called a telson used to right themselves when overturned. These organisms spawn in intertidal sandy beach zones, and local species face threats from habitat degradation and unregulated harvesting.

146. (A) Blooms reduce light penetration, starving the benthic seagrasses of sunlight
Coastal eutrophication driven by nutrient runoff stimulates explosive phytoplankton and macroalgal blooms. These massive algal mats block solar radiation, severely reducing light penetration through the water column. Starved of the light necessary for photosynthesis, benthic seagrass meadows experience high mortality, leading to sediment destabilization and the collapse of the associated ecosystem.

147. (A) Sea-level rise pushing habitats landward and fixed human infrastructure
The phenomenon of coastal squeeze describes the physical entrapment of sensitive intertidal habitats like salt marshes and mangroves. As rising sea levels push these ecosystems landward, their migration is blocked by hard, artificial human infrastructure such as seawalls, roads, and urban developments. Consequently, the intertidal habitat is squeezed out, leading to severe ecological loss.

148. (A) Inclusion of critical source habitats integrated into a broader dispersal network
Designing Marine Protected Areas for fisheries spillover requires key spatial considerations. The boundary must enclose critical source habitats, such as spawning grounds and larval nurseries. Integrating these sites into a broader ecological network ensures larval dispersal and adult fish movement across boundary limits, enhancing fish biomass in adjacent harvested waters.

149. (A) Establish a scientific basis for the improvement of relationships between people and their environments, promoting sustainable development
The UNESCO Man and the Biosphere programme is designed to establish a scientific foundation for improving the relationship between human populations and their surrounding environments. It promotes sustainable development by utilizing concentric zonation models that conserve biodiversity while supporting compatible socio-economic activities and local cultural values.

150. (A) Both A and R are true and R is the correct explanation of A.
The classification of territorial waters under CRZ-IV regulates developmental activities from the Low Tide Line out to twelve nautical miles. This regulatory oversight is designed to protect marine ecosystems, including submerged coral reefs and seagrass meadows, from maritime pollution, discharge of effluents, and unregulated industrial exploitation, ensuring sustainable coastal resource use.

151. (A) Paddy fields and human-made water bodies constructed specifically for drinking water purposes
India's Wetland Conservation Rules define and protect diverse natural wetlands, including mangrove swamps, lagoons, and high-altitude lakes. However, the legal definition explicitly excludes active paddy fields and human-made water structures built specifically for irrigation or drinking water. This exclusion prevents regulatory conflicts with essential agricultural practices and basic public utility infrastructure.

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152. (A) Schedule I
Schedule I of India's Wildlife Protection Act is designed to provide the highest degree of legal protection for highly threatened species. Marine turtles, cetaceans, and Dugongs are listed under this schedule, making hunting or trading them a severe criminal offense. Violations carry maximum legal penalties, including mandatory prison terms and substantial non-bailable fines.

153. (A) Licensing specimens of selected species defined by three Appendices
The Convention on International Trade in Endangered Species regulates the global trade of threatened wildlife through a system of import and export permits. Species are classified into three Appendices based on the level of threat they face from trade. This licensing system ensures that international commerce does not compromise the survival of wild populations.

154. (A) Electrical stimulation through frames to accelerate biogenic calcification
Biorock technology is an innovative coral reef restoration technique that utilizes low-voltage

neighboring habitats. This elevated diversity occurs because the transition zone blends physical and biological resources from both adjacent ecosystems.

136. (A) Serving as a major source of commercial limestone extraction
Mangrove forests provide critical ecological services, including coastal shoreline protection from cyclonic storm surges, sediment trapping to improve water quality, and nursery grounds for juvenile fish. Unlike coral reefs, they do not consist of calcareous frameworks, meaning they do not serve as a source for commercial limestone extraction, which is highly destructive.

137. (A) Waxy cuticles, sunken stomata, and succulent leaf tissues
Mangroves inhabit intertidal zones where fresh water is physiologically scarce due to high soil salinity. To minimize water loss, their leaves possess specialized anatomical adaptations. These features include thick, waxy cuticles to reduce evaporation, sunken stomata that trap moisture, and succulent water-storing tissues that help maintain cell turgor and regulate salt concentrations.

138. (A) The reef crest
The reef crest represents the shallowest zone of a coral reef, positioned to receive the highest impact of incoming wave energy. Because of this severe physical stress, it is dominated by highly robust, encrusting, or sturdy branching corals capable of withstanding mechanical force. This zone absorbs wave energy, protecting the sheltered lagoon behind it.

139. (A) Efficient recycling of nutrients between host and symbiotic zooxanthellae
The rapid growth of hermatypic coral reefs in nutrient-poor tropical waters is driven by the efficient recycling of nutrients between the coral host and its symbiotic zooxanthellae. Metabolic wastes produced by the coral polyp are directly utilized by the photosynthesizing algae, which in turn produce organic carbon molecules that fuel reef calcification and growth.

140. (A) P-3, Q-4, R-1, S-2
Specialized physiological adaptations enable aquatic flora to survive in distinct coastal ecosystems. Freshwater hydrophytes rely on porous aerenchyma tissue to transport oxygen to submerged roots. Salt marsh halophytes utilize leaf salt glands to excrete excess salt, true mangroves exhibit viviparous seed germination, and marine seagrasses have evolved submerged hydrophilic pollination mechanisms.

141. (A) Epifauna live on the sediment surface, while infauna are burrowing organisms living within the sediment
Benthic organisms in coastal mudflats are classified by their spatial habitat niches. Epifauna inhabit the surface of the sediment, feeding on organic detritus or benthic microalgae. Conversely, infauna are specialized burrowing organisms that live within the sediment profile, relying on distinct morphological adaptations to survive waterlogged, anoxic conditions beneath the mud surface.

142. (A) The reduction in the frequency and duration of tidal inundation
The physical transition between lower and upper salt marsh zones is primarily dictated by the frequency and duration of tidal inundation. Lower marshes are flooded daily, creating severe soil anoxia and high salinity. Upper marshes are positioned at higher elevations, receiving tidal water only during extreme spring tides, which reduces environmental stress and allows different vegetation.

143. (A) A network of hedgerows, ditches, and fragmented marshlands traditionally managed for agriculture and grazing
A bocage landscape is a human-modified landscape characterized by a complex network of hedgerows, earthen banks, drainage ditches, and small, fragmented marshlands. Traditionally managed for sustainable agriculture and livestock grazing, these systems maintain high habitat heterogeneity, serving as critical ecological corridors that support rich agricultural biodiversity within the wetland basin.

144. (A) In the lacrimal (tear) ducts near the eyes
Marine turtles ingest high amounts of salt from seawater and their prey. To maintain osmotic balance, they possess specialized salt-excreting glands anatomically located in the lacrimal ducts behind their eyes. These modified tear glands actively pump out concentrated sodium chloride, giving the appearance of crying when the turtles crawl ashore to nest.

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127. (A) Serve as a zone of cooperation where sustainable resource management practices are developed and implemented with local communities
The transition area of a Biosphere Reserve functions primarily as a zone of cooperation. This outermost region is managed to foster sustainable resource management practices by actively involving local communities, scientists, and management agencies. It integrates local economic development with biodiversity conservation, promoting sustainable agricultural, forestry, and fishery practices.

128. (A) CRZ-I B
Under coastal zone regulation frameworks, the intertidal area situated between the Low Tide Line and the High Tide Line is classified as CRZ-I B. Because this zone is subject to regular tidal inundation, it supports highly sensitive biological communities. Strict regulations apply here to protect water quality, benthic habitats, and shorelines from development.

129. (A) Are currently experiencing, or are likely to experience, changes in ecological character due to technological developments, pollution, or other human interference
The Montreux Record is a specific register maintained under the Ramsar Convention. It lists wetlands of international importance where changes in ecological character have occurred, are occurring, or are likely to occur due to technological developments, pollution, or other human interference. It highlights sites requiring urgent conservation priority and targeted management.

130. (A) Hunting is strictly prohibited, except under rare circumstances such as for specific scientific research permitted by the Chief Wildlife Warden
Under the Wildlife Protection Act of India, Schedule I species receive absolute legal protection. Hunting, capture, or trade of these animals is strictly prohibited. Exceptions are extremely rare and require explicit statutory authorization from the Chief Wildlife Warden, typically limited to scientific research or management actions that directly benefit the survival of the species.

131. (A) Lack of scientific certainty shall not postpone measures to prevent degradation
The precautionary principle states that where there are threats of serious or irreversible environmental damage, the lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent degradation. This principle is fundamental in managing sensitive coastal habitats vulnerable to rapid development, pollution, and climate change.

132. (A) Correct tidal elevation to ensure appropriate periods of inundation and exposure
Successful mangrove restoration using Rhizophora propagules depends on planting at the correct tidal elevation. This positioning ensures the developing seedlings receive appropriate cycles of inundation and exposure to the atmosphere. Incorrect elevation can lead to prolonged drowning or excessive desiccation, which significantly reduces seedling survival rates and limits restoration success.

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133. (A) Mapping resources, human uses, and jurisdictional boundaries using GIS
Spatial planning within Integrated Coastal Zone Management requires mapping environmental resources, human activities, and administrative boundaries. Utilizing Geographic Information Systems allows managers to visualize overlapping uses, identify potential conflicts, and designate appropriate zones for conservation, fisheries, and development, ensuring a balanced and sustainable approach to coastal management.

134. (A) Both A and R are true and R is the correct explanation of A.
Ecologically Sensitive Areas are dynamic landscapes whose physical and biological boundaries shift over time. Natural processes, including deltaic sediment deposition, sea-level rise, and ecological succession, continually reshape the coastal environment. Consequently, environmental policies must adopt flexible, adaptive management boundaries rather than relying on rigid, permanent administrative lines.

135. (A) I and IV
Ecotones are transitional zones where distinct habitats meet, characterized by unique ecological interactions. Due to the edge effect, these boundaries often exhibit significantly higher species richness and population densities than

electrical currents. By passing electricity through submerged steel frames, the process triggers a chemical reaction that precipitates minerals, primarily calcium carbonate, onto the structure. This mineral accretion provides a stable substrate that significantly accelerates the calcification and growth rates of transplanted corals.

155. (A) Capacity building, stakeholder engagement, and adaptive management
The long-term success of Integrated Coastal Zone Management projects depends on key operational elements. These include capacity building for local management agencies, active stakeholder engagement to ensure equitable participation, and the implementation of adaptive management strategies. This approach allows coastal policies to be adjusted based on continuous monitoring and changing environmental conditions.

156. (A) The activities are permitted but strictly monitored and managed to ensure they do not cause ecological degradation to the adjoining protected area
Within the regulatory framework of Eco-Sensitive Zones, regulated activities are not entirely prohibited. Instead, these actions are allowed under strict monitoring and management to ensure they do not cause ecological degradation to the adjoining protected area. This approach balances local socio-economic needs with the overriding goal of conserving sensitive core habitats.

157. (A) Mangrove organic detritus fueling detritivorous food webs in seagrasses
The ecotone between mangrove forests and adjacent seagrass beds exhibits exceptionally high secondary productivity. This occurs because the massive export of organic detritus from mangroves fuels highly efficient detritivorous food webs in the neighboring seagrass meadows. This trophic linkage supports large populations of juvenile fish, crabs, and shrimp that use both habitats.

158. (C) Mangrove species diversity in India is significantly higher on the western coast compared to the eastern coast.
The western coast of India is characterized by a narrow, high-energy shelf with lower riverine input, resulting in lower mangrove diversity and cover than the eastern coast. The eastern coast possesses extensive river deltas, including the Sundarbans and Mahanadi, which receive massive sediment and freshwater flows, supporting significantly higher species richness.

159. (A) Spike-like pneumatophores radiating from horizontal cable roots
The mangrove genus Sonneratia is morphologically adapted to soft, anaerobic intertidal mud through its specialized root system. It develops dense networks of heavy, spike-like pneumatophores that grow vertically upward from underground horizontal cable roots. These vertical structures contain porous tissues that facilitate vital oxygen absorption during low tide exposure.

160. (A) P-4, Q-2, R-3, S-1
Coral reefs are geomorphologically categorized based on their structural relationship to land. Fringing reefs grow directly adjacent to shorelines. Barrier reefs are separated from the coast by wide, deep lagoons. Atolls are ring-shaped reef systems enclosing a central lagoon without any island, while patch reefs are small, isolated structures within lagoons.

161. (A) Photosynthetic activity of symbiotic zooxanthellae altering local chemistry
Biogenic calcification in scleractinian corals is tightly coupled with the photosynthetic activity of their symbiotic zooxanthellae. As the algae photosynthesize, they absorb dissolved carbon dioxide, shifting the local chemical equilibrium to favor the precipitation of calcium carbonate. This biological synergy significantly accelerates the rate of skeleton accretion in shallow, sunlit waters.

162. (A) A marine protist in the genus Labyrinthula
Wasting disease in seagrass ecosystems is a highly destructive condition that can cause widespread meadow die-offs. This pathology is primarily caused by Labyrinthula, a genus of specialized marine protists. The pathogen infects leaf tissues, producing dark necrotic lesions that disrupt photosynthesis, weaken the plant, and lead to rapid tissue decay and mortality.

163. (A) The steep gradient of dissolved oxygen availability in the interstitial water, creating distinct aerobic and anaerobic zones
The vertical distribution of infauna in coastal mudflats is primarily determined by oxygen availability in the sediment. The sediment surface remains oxygenated, but oxygen drops

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cellular physiology of symbiotic zooxanthellae inside the coral tissue, causing the algae to produce toxic oxygen radicals. Consequently, the coral host expels the zooxanthellae or the algae lose their pigments, revealing the white skeleton.

183. (C) They are strictly limited to the shallow, sunlit tropical photic zone.
Ahermatypic corals are non-reef-building species that are not restricted to the shallow, sunlit photic zone. Because they generally lack photosynthesizing symbiotic zooxanthellae, they do not require sunlight. This allows them to thrive in deep, cold, and dark oceanic environments by relying entirely on heterotrophic feeding to meet their nutritional needs.

184. (A) They are highly sensitive to changes in light attenuation caused by eutrophication and increased suspended sediments
Seagrasses serve as valuable bioindicators of coastal water quality due to their extreme sensitivity to light changes. Eutrophication and sediment runoff increase water turbidity, reducing light penetration to the seabed. Because seagrasses have high photosynthetic light requirements, reduced light levels lead to rapid meadow decline, signaling environmental degradation in coastal systems.

185. (B) III, I, II, IV
Primary succession on a prograding coastal mudflat follows a distinct sequence. First, gentle tidal currents deposit fine silts and clays to build the mudflat. Next, microscopic epipelic diatoms colonize and stabilize the surface. This allows pioneer halophytes like Salicornia to establish, trapping more sediment and driving succession toward complex salt marshes.

186. (A) Anoxic conditions saturated with toxic hydrogen sulfide
Infauna living deep within muddy coastal substrates face severe chemical and physical challenges. The fine sediment restricts water flow and oxygen diffusion, creating highly anoxic conditions. Additionally, anaerobic microbial metabolism produces high concentrations of toxic hydrogen sulfide, requiring specialized physiological and behavioral adaptations, such as respiratory tubes or sulfide-binding proteins, to survive.

187. (A) The continuous accumulation of partially decayed organic matter under waterlogged, anoxic conditions
Under the Ramsar Convention, a peatland is characterized by the long-term accumulation of partially decayed organic material. These wetlands develop in waterlogged environments where continuous anoxic conditions suppress microbial decomposition. Over time, dead plant matter accumulates as peat, creating highly efficient terrestrial carbon sinks that support unique acidophilic biological communities.

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188. (A) Keoladeo National Park
Keoladeo National Park in Rajasthan is a globally significant freshwater wetland listed in the Montreux Record. Historically, it served as a critical wintering ground for the critically endangered migratory Siberian Crane. The wetland's complex hydrological and habitat structure supports immense wintering waterbird diversity, making its ecological preservation a high conservation priority.

189. (A) Buffering eggs against temperature fluctuations and influencing sex ratio
The depth of the nest chamber dug by female sea turtles is critical for embryonic development. A deep nest buffers the developing eggs from daily surface temperature fluctuations, maintaining a stable microclimate. This thermal stability is essential because the average incubation temperature determines the sex ratio of the hatchlings through temperature-dependent determination.

190. (A) Both A and R are true and R is the correct explanation of A.
The biological harvest of horseshoe crab blood poses significant ecological threats. High collection demands cause substantial post-release mortality and reduce reproductive output in returned crabs. This population decline directly affects the coastal food web, particularly for migratory shorebirds that depend on abundant horseshoe crab eggs to fuel their long migrations.

191. (A) Infrastructure like tidal barrages severing hydrological connectivity
Habitat fragmentation in estuarine ecosystems is primarily caused by human development. The construction of infrastructure, such as tidal barrages, dams, and dikes, severs natural hydrological connectivity. This physical barrier

protect shoreline ecosystems from destructive construction while allowing sustainable, low-impact local development beyond the boundary.

173. (A) National Wetland Committee
The National Wetland Committee is the primary national authority established to oversee the implementation of India's Wetland Conservation Rules. This advisory body is responsible for formulating policy guidelines, reviewing state wetland management proposals, and monitoring the ecological character of notified wetlands, ensuring coordinated conservation efforts across different states.

174. (C) A is true but R is false.
While harvesting horseshoe crabs in India is strictly prohibited under the Wildlife Protection Act, they are listed under Schedule IV. This classification means capture and trade are heavily restricted and require explicit permits, but it does not represent an absolute, unconditional ban on research use under all circumstances when authorized by conservation officers.

175. (A) Establishing a Marine Protected Area to safeguard a critical coral reef habitat within its natural environment
In-situ conservation focuses on protecting wild species and biological diversity within their natural habitats. Establishing a Marine Protected Area to safeguard a critical coral reef ecosystem is a prime example of this strategy. It allows ecological processes, species interactions, and natural selection to continue undisturbed, preserving ecosystem resilience.

176. (A) Establishing historical tidal hydrology by breaching artificial barriers
Restoring abandoned, hypersaline salt pans into functional salt marsh ecosystems depends on hydrological rehabilitation. Breaching artificial dykes and levees allows natural tidal cycles to return. This tidal flushing reduces extreme soil salinity, delivers sediment, and transports native seeds, facilitating passive vegetation recruitment and restoring natural salt marsh succession.

177. (A) Safeguarding life and property while allowing natural coastal processes
Setback lines are critical spatial planning tools used in coastal zone management. They establish dynamic boundaries that restrict permanent construction near the shoreline. The primary objective is to safeguard human life and coastal property from storm surges and erosion, while allowing natural coastal processes, beach dynamics, and habitat migration to continue unimpeded.

178. (A) The Gadgil Committee and the Kasturirangan Committee
The demarcation of Ecologically Sensitive Areas in the Western Ghats was prominently assessed by the Western Ghats Ecology Expert Panel, led by Madhav Gadgil, and the subsequent High-Level Working Group, led by K. Kasturirangan. These committees evaluated biodiversity, environmental threats, and developmental pressures to formulate regulatory guidelines for conservation.

179. (A) Halocline
In estuarine ecotones, a steep salinity gradient often prevents the immediate mixing of riverine fresh water and incoming seawater. This physical barrier creates a distinct vertical stratification known as a halocline. The halocline separates the lighter, less saline water at the surface from the denser, high-salinity marine water flowing along the bottom.

180. (A) P-2, Q-3, R-4, S-1
Mangrove genera exhibit unique morphological and physiological adaptations to occupy specific intertidal zones. Rhizophora is characterized by arching stilt roots and viviparous propagules. Avicennia features spike-like pneumatophores and salt-excreting leaves. Heritiera develops blind root pegs in low-salinity zones, while Nypa grows as a trunkless palm adapted to muddy brackish margins.

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181. (A) Casparian strip of the endodermis
The physiological mechanism of salt exclusion in specialized mangrove species is located at the root level. The Casparian strip within the root endodermis acts as a highly selective barrier, utilizing ultrafiltration to block the passive uptake of sodium and chloride ions. This barrier allows water to enter the vascular tissue while maintaining low internal salinity.

182. (A) Symbiotic zooxanthellae expulsion or loss of photosynthetic pigments
Coral bleaching is triggered by environmental stress, most notably elevated sea surface temperatures. This thermal stress disrupts the

108. (A) Appendix II
Scleractinian hard corals are listed under Appendix II of the Convention on International Trade in Endangered Species. This designation means that while they are not necessarily threatened with immediate extinction, their international trade must be strictly regulated. Exporting coral specimens requires official permits verifying that harvesting is sustainable and legally obtained.

109. (A) Invasiveness outcompeting native flora and altering natural ecosystem dynamics
Utilizing non-native species for coastal habitat restoration presents severe ecological risks. Introduced plants can easily become invasive, rapidly outcompeting native flora for limited space, light, and nutrients. This disruption alters natural ecosystem structures, degrades native biodiversity, and impacts key coastal food webs, often reversing the intended benefits of the restoration project.

110. (A) To enhance local fisheries production and biodiversity by providing shelter and breeding grounds
Deploying artificial reefs in degraded nearshore waters is a common conservation technique. These concrete or steel structures introduce physical, three-dimensional complexity to barren seafloors. By providing shelter from predators and stable attachment surfaces for sessile organisms, artificial reefs create productive feeding and breeding grounds that enhance local biodiversity and fisheries.

111. (A) I, III, and V
Integrated Coastal Zone Management is guided by core principles that promote effective governance. These include adaptive management, which allows strategies to evolve as new data emerges. It also relies on a holistic, ecosystem-based approach to capture land-sea interactions, and demands broad public participation to ensure equitable stakeholder engagement in coastal planning.

112. (A) Commercial mining, large hydroelectric projects, and polluting industries
Declaring an Eco-Sensitive Zone around a protected area is designed to restrict specific high-impact anthropogenic activities. Regulatory focus is placed on prohibiting or strictly managing destructive industries, commercial mining, and large hydroelectric projects. This buffer protects fragile core ecosystems from physical degradation, pollution, and habitat fragmentation.

113. (A) The anoxic sediments where root, rhizome, and trapped allochthonous organic matter accumulate
In seagrass meadows, the majority of blue carbon is sequestered within the underlying sediments. The physical structure of the seagrass canopy slows currents, allowing organic-rich particles to settle. The root and rhizome networks bind these deposits in highly anoxic soils, where lack of oxygen prevents decomposition and traps carbon for millennia.

114. (B) Diverse true mangrove families alongside various associates
The taxonomy of the Indian mangrove ecosystem is characterized by high biological diversity. It consists of multiple families of true mangroves, which are intertidal specialists with distinct physiological adaptations. These species grow alongside diverse mangrove associates that tolerate saline coastal conditions but are not exclusively restricted to the intertidal zone.

115. (A) Knee roots (pneumatophores) that loop above and below the soil surface
Bruguiera gymnorhiza is morphologically adapted to oxygen-depleted, waterlogged intertidal soils through the development of specialized knee roots. These horizontal roots grow outward from the trunk and periodically loop upward above the mud surface before growing back down. The exposed loops contain porous lenticels that facilitate gas exchange during low tide.

116. (A) Barrier reef system
The Great Barrier Reef is geomorphologically classified as a barrier reef system. Located off the coast of Australia, it consists of a massive, linear network of individual reefs separated from the mainland by a wide, deep lagoon. It represents the largest biogenic structure on Earth, providing critical marine habitats.

117. (A) Both A and R are true and R is the correct explanation of A.
Ahermatypic corals are not restricted to shallow photic zones because they lack symbiotic zooxanthellae. Unlike hermatypic corals, they do not require solar radiation for photosynthesis.

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blocks the movement of migratory fish, alters sediment transport, and isolates biological subpopulations, reducing overall ecosystem resilience and genetic diversity.

192. (A) It disrupts olfactory and auditory processing, impairing predator detection
Ocean acidification impacts marine organisms beyond simple calcification. In reef fishes, elevated carbon dioxide concentrations alter brain chemistry, disrupting sensory processing. This neural impairment compromises olfactory and auditory pathways, making it difficult for juvenile fish to detect chemical cues from predators, locate suitable habitats, or navigate back to coral reefs.

193. (A) No-Take Zones prohibit all forms of extractive activities, including fishing, whereas Multiple-Use Zones allow regulated levels of exploitation alongside conservation
The management of Marine Protected Areas relies on spatial zonation to balance conservation and human use. No-take zones strictly prohibit all extractive activities, including commercial and recreational fishing, to preserve biodiversity and encourage resource recovery. Conversely, multiple-use zones allow regulated levels of fishing and tourism alongside conservation goals.

194. (A) Complete militarization of the transition zone to prevent international border incursions
Biosphere Reserves operate under the Man and the Biosphere programme to achieve key objectives. These functions include conserving biodiversity and cultural landscapes, fostering ecologically and socially sustainable economic development, and providing logistic support for scientific research, environmental monitoring, and education. Military border enforcement is not a core function of this environmental framework.

195. (C) I, III, II, IV
Coastal Regulation Zone notifications utilize a specific numerical hierarchy to organize coastal boundaries. This spatial framework starts with CRZ-I protecting highly sensitive ecosystems, followed by CRZ-III managing rural regions, CRZ-II regulating developed urban shorelines, and CRZ-IV encompassing offshore territorial waters extending twelve nautical miles out to sea.

196. (A) Draining a wetland entirely to build a commercial shopping complex
The wise-use principle of the Ramsar Convention requires that any human use of a wetland must maintain its natural ecological character. Completely draining a wetland to construct a commercial shopping complex represents a severe violation of this principle, as it destroys hydrological function, eliminates biodiversity, and permanently removes the wetland from the landscape.

197. (B) The Whale shark (Rhincodon typus)
The Whale shark is a highly threatened marine species granted the highest level of legal protection in India. By being listed under Schedule I of the Wildlife Protection Act, hunting, capturing, or trading this gentle giant is strictly prohibited. Violators face severe criminal penalties, including mandatory imprisonment and heavy fines.

198. (A) The variability among living organisms from all sources including terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part
The Convention on Biological Diversity defines biological diversity as the variability among living organisms from all environmental sources. This definition encompasses diversity within species, between different species, and across complex ecosystems, including terrestrial, marine, and other aquatic systems. It highlights that biodiversity includes genetic, taxonomic, and ecological components.

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199. (A) Maximizing growth and survivorship in protected environments before reef outplanting
The nursery phase of coral gardening aims to optimize the initial survival and growth of fragile coral fragments. By culturing these fragments in sheltered, land-based or mid-water nurseries, managers protect them from sedimentation, algae competition, and thermal stress. This stewardship produces healthy, resilient colonies that are better equipped to survive subsequent outplanting.

200. (A) The sharing of power and responsibility for resource management between the government and local resource users
Co-management within coastal zone planning is defined as a collaborative management partnership. This model distributes decision-making authority and responsibility for resource

in traditional resource extraction that does not compromise conservation goals.

238. (A) Balancing conservation with sustainable management and socio-economic development
The transition area is the outermost zone of a Biosphere Reserve. Its primary function is to balance biodiversity conservation with sustainable resource management and socio-economic development. This zone serves as an area of cooperation where local communities, researchers, and industries work together to implement sustainable agricultural, forestry, and fishery practices.

239. (A) The Environment (Protection) Act, 1986
India's Coastal Regulation Zone notifications are issued under the statutory powers conferred by the Environment Protection Act of 1986. This overarching federal legislation empowers the central government to regulate developmental activities, manage waste discharge, and protect fragile coastal and marine habitats from environmental degradation, ensuring sustainable coastal zone governance.

240. (A) Remote sensing using satellite imagery (e.g., from ISRO's RESOURCESAT) integrated with Geographic Information Systems (GIS)
The National Wetland Decadal Change Atlas is generated using advanced geospatial technologies. Researchers utilize high-resolution remote sensing data from satellite imagery, such as ISRO's RESOURCESAT, integrated with Geographic Information Systems. This methodology allows scientists to track long-term changes in wetland boundaries, monitor water spread, and identify threats across large geographical scales.

241. (D) A is false but R is true.
India's Wildlife Protection Act does not completely exclude marine flora from protection. While the primary focus of early conservation schedules was on terrestrial and marine animals, subsequent legislative amendments have incorporated sensitive marine species. The Act contains provisions to protect critical habitats, including mangrove forests, which are regulated under broader environmental laws.

242. (A) The safe transfer, handling, and use of Living Modified Organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biodiversity
The Cartagena Protocol is an international treaty operating under the Convention on Biological Diversity. Its primary focus is to ensure the safe transfer, handling, and transboundary movement of Living Modified Organisms produced by modern biotechnology. The protocol aims to protect biological diversity from potential risks posed by modified organisms.

243. (A) Adjusting management strategies based on observed responses and new knowledge
Adaptive management is a structured, iterative decision-making process utilized in coastal ecological restoration. This approach involves continuously monitoring restored habitats and adjusting conservation strategies as new data and environmental responses emerge. By treating management actions as learning opportunities, restoration practitioners can optimize outcomes and adapt to unexpected ecosystem changes.

244. (A) Coordinates policies across multiple sectors and administrative coastal boundaries
Integrated Coastal Zone Management differs from traditional sectoral management by taking a comprehensive approach. Rather than managing coastal activities in isolation, this framework coordinates environmental policies across multiple sectors, including fisheries, tourism, and shipping. It bridges administrative and natural boundaries, ensuring sustainable development while preserving fragile coastal ecosystems.

245. (B) II, I, IV, III
Along tropical coastlines, ecosystems are distributed along a gradient from offshore to inland environments. The sequence begins with high-energy offshore open waters and fringing coral reefs. This transitions into intertidal estuarine mudflats and salt marshes, moves landward into dense mangrove forests, and ultimately reaches inland freshwater riverine wetlands.

246. (A) A transition area between two adjacent but distinct ecosystems, often exhibiting characteristics of both and possessing unique species
An ecotone is a dynamic transitional zone where two adjacent but distinct ecosystems meet. It possesses a mix of physical and biological characteristics from both neighboring habitats

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stems to dilute high internal salt concentrations. This physiological mechanism prevents sodium ions from reaching toxic levels inside plant cells, enabling survival in hypersaline salt pan soils.

210. (A) Keibul Lamjao National Park (Loktak Lake)
Keibul Lamjao National Park, situated within Loktak Lake in Manipur, is a unique freshwater wetland of international importance. It is characterized by phumdis, which are floating mats of soil, organic matter, and vegetation. This floating habitat supports the endangered Eld's deer and represents a globally unique wetland ecosystem.

211. (C) III and IV
Marine turtles exhibit highly specialized ecological traits. Green turtles are unique herbivorous adults grazing on seagrasses, and leatherbacks are jellyfish specialists lacking bony scutes. Conversely, Hawksbills possess a distinct bird-like beak to forage on sponges, and Olive Ridleys are small, aggregate-nesting sea turtles rather than solitary giants.

212. (A) High post-bleeding mortality reducing spawning events and starving migratory shorebirds
The biomedical harvesting of horseshoe crab blood can cause significant ecological harm to coastal food webs. Bleeding stress leads to high post-release mortality and reduces spawning frequency on sandy beaches. This reduction in egg abundance directly impacts migratory shorebirds, which depend on these nutrient-rich eggs to survive long-distance journeys.

213. (A) A condition where dissolved oxygen concentrations fall below the level necessary to sustain most marine animal life (typically below 2 mg/L)
In coastal ecosystems, hypoxia is defined as a critical depletion of dissolved oxygen, typically dropping below two milligrams per liter. This oxygen deficiency is caused by the bacterial decomposition of massive organic algal blooms triggered by nutrient pollution. Hypoxia suffocates benthic fish and shellfish, leading to extensive marine mortality and dead zones.

214. (A) Hydrogen ions react with carbonate ions, reducing aragonite saturation states
Ocean acidification impairs coral calcification by altering seawater chemistry. As the oceans absorb rising atmospheric carbon dioxide, the concentration of hydrogen ions increases, lowering pH. These hydrogen ions bind with carbonate ions, reducing the saturation state of aragonite. This makes it difficult for corals to access the building blocks needed for skeletal growth.

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215. (A) P-2, Q-4, R-3, S-1
Key management concepts guide Marine Protected Areas. The spillover effect describes the net export of fish biomass to adjacent waters. No-take zones are strictly managed reserves prohibiting all extraction, biological connectivity describes habitat linkages that facilitate migrations, and paper parks are legally designated areas that lack active field enforcement.

216. (A) Create a spatial framework balancing strict conservation (core) with sustainable use and human development (buffer and transition)
The spatial zonation of UNESCO Biosphere Reserves is designed to balance conservation with human development. The strictly protected core zone secures native biodiversity. The surrounding buffer zone supports compatible research, education, and ecotourism, while the outer transition area acts as a zone of cooperation for sustainable agricultural and traditional resource use.

217. (A) Prohibited within the CRZ, subject to specific exemptions for activities requiring foreshore facilities (e.g., ports)
Under coastal regulation zone guidelines, setting up new industries or expanding existing facilities is generally prohibited. This restriction prevents industrial pollution and shoreline degradation. Exceptions are limited to essential activities that require foreshore facilities, such as ports, harbors, and defense installations, which are subject to environmental clearances.

218. (A) The Ramsar Convention on Wetlands
The Montreux Record is a voluntary register maintained under the Ramsar Convention on Wetlands. It lists wetlands of international importance where changes in ecological character have occurred, are occurring, or are likely to occur due to technological developments, pollution, or other human interference, guiding global conservation attention to high-risk sites.

219. (A) Both A and R are true and R is the correct explanation of A.
Under the Wildlife Protection Act, Schedule I species receive absolute legal protection from hunting and trade. However, the Chief Wildlife Warden holds statutory authority to permit hunting under rare, extreme exceptions. This includes situations where an animal has become a direct threat to human life or is disabled beyond any possible recovery.

220. (A) Ensure that international trade in specimens of wild animals and plants does not threaten their survival in the wild
The primary purpose of the Convention on International Trade in Endangered Species is to regulate global trade in specimens of wild animals and plants. By utilizing a system of permits and categorizing species into three Appendices, the treaty ensures that international commerce does not threaten the long-term survival of wild populations.

221. (A) Assessment and restoration of local hydrological regimes and tidal frequencies
Successful mangrove ecological restoration depends on restoring natural hydrological regimes. Prior to planting, managers must assess and restore natural tidal flow and inundation frequencies. Proper water movement regulates soil salinity, prevents toxic chemical accumulation, and delivers sediment and native propagules, ensuring high survival rates for developing seedlings.

222. (A) Analyzing spatial/temporal human activity distribution to achieve multi-sector goals
Marine Spatial Planning is a key tool within Integrated Coastal Zone Management frameworks. Its main objective is to analyze the spatial and temporal distribution of human activities within coastal and marine waters. By mapping these uses, planners can allocate distinct zones, minimize conflicts between sectors, and secure long-term marine biodiversity conservation.

223. (A) I, III, and V
Ecologically Sensitive Areas are characterized by high biological diversity, high species richness, and elevated levels of endemism. These landscapes are highly vulnerable to human-induced disturbances and often function as vital biological corridors that link fragmented habitats. Consequently, these areas require strict regulatory guidelines to prevent habitat degradation and species loss.

224. (A) Vertical accretion of anoxic sediments preserving carbon without decomposition
Blue carbon ecosystems sequester carbon more efficiently than terrestrial forests due to unique sediment dynamics. As these plants grow, their root systems trap organic matter in waterlogged, highly anoxic soils. This lack of oxygen slows down microbial decomposition, allowing carbon to accumulate and remain buried for centuries as the sediment vertically accretes.

225. (A) Sonneratia alba
Sonneratia alba, commonly known as the apple mangrove, is a pioneering true mangrove species. It is distinguished by its green, spherical fruits that resemble apples and its dense networks of vertical, spike-like pneumatophores. This species is highly tolerant of high salinity and is commonly found in lower intertidal zones along sandy coastlines.

226. (A) Propagule
In true viviparous mangroves like Rhizophora, the germinating seed develops an elongated, photosynthetic cylinder called a propagule while still attached to the parent tree. This mature structure eventually drops into the water, where its buoyancy allows it to drift on tidal currents or settle vertically in soft mud to rapidly establish.

227. (A) A deep, navigable lagoon separating the reef from the adjacent shoreline
Fringing reefs and barrier reefs are geomorphologically distinguished by the presence of a lagoon. Fringing reefs grow directly adjacent to the shoreline with no separating channel. Conversely, barrier reefs run parallel to the shore but are separated from the mainland by a wide, deep lagoon that is often navigable by shipping vessels.

228. (A) A photoprotective mechanism regulating the light environment for the zooxanthellae
Fluorescence in reef-building corals is believed to function as a photoprotective adaptation. Specialized fluorescent proteins absorb high-energy, potentially damaging ultraviolet light and re-emit it as longer, less harmful wavelengths of blue or green light. This regulation creates an optimal light environment that protects the

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delicate photosynthetic machinery of symbiotic zooxanthellae.

229. (A) Vegetative propagation via rhizome extension and sexual reproduction via submerged flowers and seeds
Seagrasses reproduce through both asexual and sexual pathways to maintain meadows. Vegetative propagation involves the horizontal extension of subterranean rhizomes, which produces genetically identical clones and stabilizes local sediment. Sexual reproduction occurs completely submerged, relying on water currents to transport specialized pollen to flowers, resulting in seed production and genetic dispersal.

230. (A) The physical mixing and oxygenation of sediments caused by the burrowing and feeding activities of benthic organisms
Bioturbation refers to the physical disruption, mixing, and oxygenation of benthic sediments caused by the burrowing and feeding activities of marine organisms. On coastal mudflats, infauna like worms and bivalves churn the sediment, bringing nutrients to the surface and allowing oxygen to penetrate deeper, which heavily regulates benthic community structure.

231. (A) Both A and R are true and R is the correct explanation of A.
Salt marsh plants exhibit distinct vertical zonation patterns along a stress gradient. Species in the lower marsh are highly specialized to tolerate frequent tidal flooding, high soil salinity, and severe anoxia. Conversely, upper marsh species face less physical stress but are superior competitors, displacing flood-tolerant halophytes to lower, more stressful elevations.

232. (C) A high concentration of highly oxidized, bright red iron compounds indicating continuous aeration
Hydric soils are characterized by prolonged saturation that restricts oxygen diffusion. This anaerobic environment leads to organic matter accumulation, a strong smell of hydrogen sulfide, and distinct redoximorphic features such as blue-grey colors or mottling. Highly oxidized, bright red iron soils indicate aerated, well-drained conditions, which are not characteristic of hydric soils.

233. (A) Creating a stable, insulated, and protected micro-environment for development
During the nesting process, the female sea turtle digs a specialized egg chamber in the dry sand. This deep, flask-shaped chamber is designed to create a highly stable microclimate. It buffers the eggs from surface temperature fluctuations, maintains humidity, and protects the clutch from predators and high tides, ensuring successful embryonic development.

234. (A) Amebocytes
The biomedical manufacture of the Limulus Amebocyte Lysate test depends on extracting blue hemolymph from horseshoe crabs. The specific cell type targeted is the amebocytes, which contain specialized clotting proteins. These proteins react immediately by gelling in the presence of Gram-negative bacterial endotoxins, making them vital for testing medical equipment safety.

235. (A) III, IV, V, II, I
Coastal eutrophication triggers a distinct ecological cascade. First, excess nutrient runoff enters coastal waters. This nutrient enrichment drives the rapid proliferation of algal blooms. As the algal biomass dies and sinks, aerobic bacteria decompose the organic matter, rapidly depleting dissolved oxygen. This bottom-water anoxia suffocates benthic fauna, creating marine dead zones.

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236. (A) Thermal expansion of seawater and melting of land-based glaciers and ice sheets
Global warming contributes to sea-level rise through two primary physical mechanisms. First, rising atmospheric temperatures cause the thermal expansion of ocean waters. Second, elevated temperatures melt land-based ice sheets and glaciers, transferring freshwater into the basins. This rising sea level threatens sensitive coastal habitats with prolonged inundation and erosion.

237. (D) Category VI
An IUCN Category VI Protected Area is explicitly designated to facilitate the sustainable use of natural resources. These areas are managed to protect natural ecosystems and conserve biodiversity while simultaneously supporting compatible, low-impact economic activities. This framework allows local communities to engage

management between government agencies and local resource users, such as traditional fishers. This approach enhances compliance, incorporates valuable traditional ecological knowledge, and ensures coastal policies remain socially equitable.

201. (A) Its capacity to provide vital ecosystem services, act as a biological corridor, and harbor rare or endangered taxa
Identifying an Eco-Sensitive Area depends on evaluating key ecological indicators. Primary factors include the area's capacity to deliver essential ecosystem services, function as a biological corridor for wildlife migration, and provide critical habitat for rare, endemic, or endangered species. These characteristics guide regulatory boundaries to preserve fragile biological systems.

202. (A) The transition zone often exhibits greater species diversity and higher population densities than either of the adjacent discrete ecosystems
Ecotones are transitional zones where distinct habitats meet, characterized by unique ecological interactions. Due to the edge effect, these boundaries often exhibit significantly higher species richness and population densities than neighboring habitats. This elevated diversity occurs because the transition zone blends physical and biological resources from both adjacent ecosystems.

203. (C) Mangroves achieve their greatest biomass and structural complexity in hyper-arid, hypersaline coastal deserts.
Mangroves are specialized intertidal forests that thrive in tropical and subtropical latitudes, where they rely on warm ocean currents to disperse their buoyant propagules. However, they achieve their maximum structural complexity and biomass in humid, high-rainfall regions with abundant riverine sediment delivery, rather than in hyper-arid, hypersaline coastal desert environments.

204. (A) Salt secretion
Salt secretion is a vital physiological adaptation employed by several true mangrove species to manage excess internal salt. This active transport process uses specialized salt glands located on the leaf epidermis to pump concentrated salt solution out of the plant. As the water evaporates, visible salt crystals form on the leaves.

205. (A) Both A and R are true and R is the correct explanation of A.
Coral reefs are widely referred to as the rainforests of the sea due to their immense biological richness. Despite existing in nutrient-poor tropical waters, they exhibit exceptionally high gross primary productivity. This biological efficiency is driven by the internal recycling of nutrients between corals and symbiotic zooxanthellae, supporting complex marine food webs.

206. (A) They lack symbiotic zooxanthellae and rely entirely on capturing passing zooplankton and suspended organic particulate matter using their tentacles
Deep-water ahermatypic corals are adapted to survive in dark, cold, and aphotic oceanic zones. Because they lack photosynthetic symbiotic zooxanthellae, they do not rely on solar radiation. Instead, these corals meet their nutritional needs by extending their polyps and tentacles to capture passing zooplankton and suspended organic particulate matter from deep water currents.

207. (A) The propellers of shallow-draft motorized boats cutting through the grass beds and ripping up the rhizome mats
Propeller scarring is a major physical threat to shallow-water seagrass beds. This damage occurs when shallow-draft motorized vessels navigate over shallow meadows, allowing their spinning propellers to slice through the seagrass canopy. This action tears up the subterranean rhizome mats, leaving bare trenches in the sediment that take years to recover.

208. (A) The presence of pioneer sand-binding vegetation, such as Spinifex or Ipomoea, to trap aeolian (wind-blown) sand
The formation of primary coastal sand dunes depends on the presence of pioneer sand-binding vegetation. Hardy plants like Spinifex or Ipomoea can survive in high salinity and shifting sands. Their sprawling canopy and roots slow wind speeds, trapping wind-blown sand particles and stabilizing the sediment to initiate primary dune succession.

209. (A) Salicornia
Members of the genus Salicornia are highly specialized halophytes that manage osmotic stress through tissue succulence. These plants accumulate water within their fleshy, modified

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and frequently supports unique species adapted to these boundary conditions. This ecological blending typically results in elevated species richness and density.

247. (A) Intertidal specialists that play a major role in community structural density
True mangroves are specialized intertidal trees that grow exclusively within the saline, tidally inundated coastal zone. They possess advanced morphological and physiological adaptations, such as salt-excluding roots and respiratory pneumatophores, and play a dominant role in forming the structural canopy of the mangrove forest, unlike facultative associates.

248. (A) Provide structural support and facilitate oxygen exchange in anoxic environments
Bruguiera species are adapted to unstable, anaerobic intertidal sediments through specialized knee roots. These horizontal roots grow outward and loop periodically above the mud before growing back down. The exposed loops contain porous lenticels that facilitate vital oxygen transport to the submerged root system, while providing mechanical stability.

249. (A) Cold-water upwelling systems and cool boundary currents limiting thermal ranges
The formation of extensive coral reefs on the western coasts of major continents is restricted by oceanographic parameters. These regions are dominated by strong cold-water upwelling systems and cool eastern boundary currents. These currents lower sea surface temperatures below the thermal threshold required for hermatypic coral growth and calcification.

250. (A) Mass coral bleaching as corals expel zooxanthellae or algae lose pigments
The mutualism between corals and zooxanthellae is highly sensitive to thermal stress. Even a minor sea surface temperature increase of one to two degrees above the summer average can disrupt algal photosynthesis. This stress causes the coral to expel its zooxanthellae, leading to mass coral bleaching and leaving the reef vulnerable.

251. (A) Canopy structural complexity providing refuge and abundant food resources
Seagrass beds function as highly effective nursery habitats due to their structural properties. The dense leaf canopy physically slows water currents and provides excellent shelter for juvenile fishes and invertebrates to hide from predators. Furthermore, the leaves host diverse epiphytic organisms, offering abundant and accessible food resources.

252. (A) Surface deposit feeding and grazing on the epipelic microalgal biofilms covering the mud surface
Epifauna on coastal mudflats rely on specialized feeding strategies to survive. Because these shifting sediments lack stable attachment surfaces, these mobile organisms move across the mud. They feed primarily by deposit feeding or grazing on rich microscopic biofilms composed of epipelic diatoms, cyanobacteria, and organic detritus on the surface.

253. (A) Superior tolerance to inundation, salinity, and anoxia with rapid lateral spread
The invasive grass Spartina alterniflora outcompetes native salt marsh vegetation through high physiological tolerances. When introduced, it adapts rapidly to prolonged tidal flooding, high soil salinity, and severe anoxia. Its robust root and rhizome networks allow for rapid vegetative expansion, displacing native plants and altering estuarine sediment dynamics.

254. (A) Both A and R are true and R is the correct explanation of A.
Freshwater wetlands function as highly efficient sinks for pollutants and heavy metals. As water flows through the dense vegetation, physical drag slows velocity, allowing suspended sediments to settle. Simultaneously, the highly anaerobic biogeochemical environment of hydric soils promotes the chemical precipitation and binding of toxic pollutants within the sediment.

255. (A) The dorsal, convex part of the shell structure
In marine turtle anatomy, the carapace refers to the dorsal, convex portion of the protective shell. This structure is typically composed of fused ribs and vertebrae covered by tough keratinous plates called scutes, except in the leatherback turtle. It provides essential protection against predators and structural support for swimming.

256. (A) It is a benthic scavenger and predator, primarily feeding on marine worms, small mollusks, and crustaceans in the mud
The horseshoe crab is a benthic scavenger and predator inhabiting coastal mudflats. It moves along the seafloor, utilizing its legs to search the

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275. (A) Primarily in mid-to-high latitude temperate and sub-arctic coastal regions, replacing mangroves
Salt marsh ecosystems are widely distributed in mid-to-high latitude temperate and sub-arctic coastal regions. In these cooler climates, they replace mangrove forests, which cannot tolerate freezing temperatures. These high-latitude marshes are dominated by salt-tolerant grasses, rushes, and shrubs, providing critical coastal stabilization and carbon sequestration services.

276. (A) Plants that are adapted to life in water or in soil that is at least periodically deficient in oxygen as a result of excessive water content
Hydrophytic vegetation is a primary biological indicator used in wetland delineation. These specialized plants are adapted to survive in saturated soils that are periodically deficient in oxygen. Anatomical adaptations, such as vertical aerenchyma tissue, allow these plants to transport atmospheric oxygen down to submerged root systems in anaerobic substrates.

277. (A) Predator satiation overwhelming predators to ensure high absolute survivors
The mass synchronous nesting behavior of Olive Ridley turtles is an evolutionary adaptation designed to achieve predator satiation. By emerging in tens of thousands over a few nights, the turtles overwhelm local predators with an abundance of food. This aggregate nesting ensures that a higher proportion of eggs and hatchlings survive.

278. (A) Lipopolysaccharide endotoxins found in Gram-negative bacterial membranes
The amebocytes within horseshoe crab blood possess a highly sensitive defense mechanism. These immune cells are exceptionally reactive to lipopolysaccharide endotoxins found in the outer membranes of Gram-negative bacteria. This sensitivity causes the hemolymph to rapidly coagulate on contact, providing the basis for the LAL test used in biomedicine.

279. (A) Coastal capital dredging and irresponsible dumping of the dredge spoil
Capital dredging and irresponsible dumping of dredge spoil cause severe ecological damage to benthic marine ecosystems. This mechanical excavation resuspends fine sediments, generating massive turbidity plumes that block sunlight. When the suspended sediment settles, it physically smothers nearby coral reefs and seagrass meadows, choking filter feeders and blocking photosynthesis.

280. (A) Absorption of CO_2 forms carbonic acid, releasing pH-lowering hydrogen ions
Rising atmospheric carbon dioxide concentrations directly drive ocean acidification through marine chemical shifts. When the oceans absorb excess carbon dioxide, it reacts with water molecules to form carbonic acid. This weak acid dissociates, releasing free hydrogen ions that lower ocean pH, making the marine environment more acidic and corrosive.

281. (A) Category Ia is for scientific research with restricted access; Category II allows managed visitation
An IUCN Category Ia Strict Nature Reserve differs from a Category II National Park in management objectives and access. Category Ia areas are managed strictly for scientific research and biodiversity conservation, with public access tightly restricted. Conversely, Category II National Parks protect ecological processes while permitting managed visitor recreation and education.

282. (A) Highly integrated ecosystems of coral reefs, seagrass meadows, and mangrove forests supporting endangered species like the Dugong
The Gulf of Mannar Biosphere Reserve is globally recognized for its integrated marine ecosystems. It features a rich mosaic of coral reefs, seagrass meadows, and mangrove forests. These habitats support immense biodiversity, including rare and endangered species like the Dugong, making its preservation a priority for international marine conservation efforts.

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283. (A) The National Centre for Sustainable Coastal Management (NCSCM)
Under national coastal regulation guidelines, the High Tide Line is scientifically mapped and demarcated by the National Centre for Sustainable Coastal Management. This authorized agency utilizes high-resolution satellite imagery, tidal data, and physical beach surveys to establish the regulatory boundary, ensuring consistent and scientifically sound coastal planning across India.

mineral accretion provides a stable substrate that accelerates the calcification and growth of transplanted corals.

266. (A) Authorizing infrastructure based on sectoral goals without public consultation
A core principle of Integrated Coastal Zone Management is a holistic, multi-sectoral approach to decision-making. Authorizing high-impact coastal infrastructure based purely on single-sector goals without public consultation directly violates this principle. Effective coastal planning requires active stakeholder engagement to minimize user conflicts and protect sensitive marine ecosystems.

267. (A) I and III
Eco-Sensitive Zones act as shock absorbers around protected areas, transitioning from highly protected core zones to areas with less regulation. These buffers do not uniformly extend ten kilometers without exception, nor do they ban all agricultural activities, which are generally permitted under sustainable guidelines to support local livelihoods.

268. (A) Degradation exposes anoxic sediments to oxygen, triggering rapid decomposition
Blue carbon stored in coastal sediments is highly vulnerable to remineralization upon habitat disturbance. Waterlogged, anoxic sediments naturally suppress microbial activity, preserving trapped carbon. However, when these habitats are dredged or drained, the sediment is exposed to oxygen, triggering rapid aerobic decomposition that releases stored carbon back into the atmosphere.

269. (A) Black mangrove
The dominant mangrove genus Avicennia is commonly known as the black mangrove. It is distinguished by its dark bark, small pale flowers, and extensive fields of vertical, pencil-like pneumatophores. This genus is highly salt-tolerant and possesses specialized salt glands on its leaf surfaces to actively excrete excess dissolved sea salt.

270. (A) IV, II, I, III
True mangroves exhibit distinct zonation patterns along coastal inundation gradients. Sonneratia typically occupies the seaward edge, adapted to frequent tidal washing. Moving landward, Rhizophora dominates the mid-intertidal zone with robust stilt roots, followed by Bruguiera, and finally Heritiera, which is situated near the landward margin in lower-salinity soils.

271. (A) Ahermatypic corals generally do not possess symbiotic zooxanthellae and therefore do not construct massive biogenic reef frameworks
Ahermatypic corals are distinguished from hermatypic species by their growth form and symbiotic relationships. They generally lack photosynthesizing symbiotic zooxanthellae, meaning they do not require sunlight. Consequently, they do not construct massive biogenic reef frameworks, allowing them to grow as solitary or small colonial organisms in deep, cold waters.

272. (A) Recovery by re-acquiring or multiplying residual zooxanthellae populations
Coral bleaching represents the breakdown of a delicate symbiotic relationship. If thermal stress is rapidly removed, moderately bleached corals can survive and recover. The coral polyps can re-acquire symbiotic dinoflagellates from the surrounding water column or allow residual zooxanthellae populations inside their tissues to multiply, restoring pigments and calcification.

273. (A) Sufficient photosynthetically active radiation reaching the benthic substrate
The global distribution of seagrasses is primarily limited by solar light penetration. Because these plants are submerged marine angiosperms, they require high levels of photosynthesizing radiation to fuel growth. Consequently, factors that increase water turbidity, such as sediment runoff and eutrophication, restrict seagrasses to shallow nearshore waters.

274. (A) Both A and R are true and R is the correct explanation of A.
Coastal mudflats appear barren but are highly productive marine ecosystems. This high productivity is driven by immense populations of epipelic microalgae and cyanobacteria that form photosynthetic biofilms on the mud. These biofilms, along with abundant organic detritus, fuel highly efficient detrital food webs that support high densities of infaunal invertebrates.

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soft sediment for food. Its diet consists primarily of small mollusks, marine worms, and soft-bodied crustaceans, making it an important link in estuarine food webs.

257. (A) Rigid coastal defenses combined with sea-level rise preventing landward migration
Coastal squeeze in estuarine environments is primarily driven by human construction. As rising sea levels push intertidal habitats landward, their natural migration is blocked by rigid coastal defenses like seawalls and dikes. Consequently, salt marshes and mangroves are compressed against these hard barriers, leading to severe habitat loss.

258. (B) II
Climate change impacts coastal ecosystems through multiple physical pathways, including storm damage and sea-level rise. However, the assertion that ocean acidification enhances coral calcification is incorrect. Acidification reduces available carbonate ions, which directly impairs the ability of corals and calcareous algae to build and maintain their calcium carbonate frameworks.

259. (A) The MPA must be vast in scale, potentially spanning international boundaries, and form part of a connected network of protected critical habitats
Protecting highly mobile, migratory pelagic species requires a large-scale approach to reserve design. Because these animals travel vast distances, small reserves are ineffective. Effective Marine Protected Areas must span large geographic scales, incorporate international boundaries, and form connected networks that protect critical corridors, feeding grounds, and spawning sites.

260. (A) Legally established and strictly protected to ensure the long-term conservation of landscapes, ecosystems, species, and genetic variation
The core zone of a UNESCO Biosphere Reserve is legally established to receive the highest level of protection. Its primary conservation objective is to secure the long-term preservation of intact ecosystems, landscapes, and genetic diversity. Human access is strictly restricted, allowing only non-destructive scientific monitoring and research.

261. (A) CRZ-I A covers ecologically sensitive areas (like mangroves and corals), whereas CRZ-I B covers the intertidal zone between the Low Tide Line and High Tide Line
India's Coastal Regulation Zone notifications distinguish between two sub-categories of highly sensitive areas. CRZ-I A encompasses critical ecological habitats such as mangrove forests, coral reefs, and sand dunes. Conversely, CRZ-I B specifically regulates the intertidal zone situated between the Low Tide Line and the High Tide Line.

262. (A) Maintenance of the wetland's ecological character, achieved through implementation of an ecosystem approach
Under national wetland rules, the wise-use principle is defined as the maintenance of the wetland's ecological character. This conservation objective is achieved through the implementation of ecosystem-based management approaches. It ensures that human activities within the wetland remain sustainable and do not degrade water quality, hydrology, or biological diversity.

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263. (D) A is false but R is true.
The Wildlife Protection Act is not limited to protecting terrestrial mammals. While early conservation efforts focused heavily on land animals, legislative amendments have incorporated diverse marine organisms. Hard corals, sea cucumbers, marine turtles, and specific shark species are listed under different schedules to receive strict legal protection from exploitation.

264. (A) The Bonn Convention
The Convention on the Conservation of Migratory Species of Wild Animals is widely known as the Bonn Convention. Signed in 1979, this intergovernmental treaty aims to conserve terrestrial, marine, and avian migratory species throughout their global ranges. It provides a legal framework for international cooperation to protect species crossing administrative borders.

265. (A) Electrolysis to accrete limestone substrate on frames, enhancing growth rates
Biorock technology is an advanced coral reef restoration method that utilizes low-voltage electrical currents. By passing electricity through submerged steel structures, the process triggers electrolysis, which precipitates dissolved minerals like calcium carbonate onto the frame. This

284. (A) Non-wetland uses including encroachment of any kind, and setting up of any industry or expansion of existing industries
India's Wetland Rules strictly prohibit activities that permanently damage notified wetlands. Regulatory restrictions forbid the conversion of wetlands to non-wetland uses, including land encroachment, reclamation, and the construction of new industries. These prohibitions prevent habitat fragmentation, preserve hydrological functions, and maintain the ecological character of sensitive aquatic ecosystems.

285. (A) Both A and R are true and R is the correct explanation of A.
All species of scleractinian hard corals in Indian waters are granted the highest tier of legal protection. Listing under Schedule I of the Wildlife Protection Act bans any extraction, commercial trade, or damage to these marine organisms. This strict classification treats violations as severe criminal offenses, carrying heavy mandatory prison sentences.

286. (A) The Ramsar Convention
The Ramsar Convention is an international treaty dedicated to the conservation and wise use of wetlands. Signed in 1971, it provides a global framework for national action and international cooperation. It aims to prevent the loss of wetlands and preserve their ecological character through sustainable management and ecosystem-based planning.

287. (A) Assessing and restoring hydrological conditions to allow for native recruitment
Restoring a coastal area denuded of mangroves due to aquaculture depends on hydrological rehabilitation. Before planting, managers must assess and restore natural tidal flows by breaching aquaculture pond dykes. This correction regulates soil salinity, oxygenates the sediment, and allows native propagules to disperse and settle naturally, ensuring successful habitat recovery.

288. (A) Coastal interconnectedness requires coordinated, holistic governance across sectors
Integrated Coastal Zone Management is built upon the premise of coastal interconnectedness. Because terrestrial and marine systems interact dynamically, effective coastal governance requires a coordinated, holistic approach. This framework bridges administrative boundaries and integrates multiple sectors, including fisheries, tourism, and conservation, to balance economic progress with ecological sustainability.

289. (A) A well-vegetated coastal foredune system
A well-vegetated coastal foredune system provides natural defense against shoreline erosion. During high-energy storm events, large waves erode the seaward dune profile, slowly releasing trapped sand back into the active beach system. This sediment buffer dampens wave energy and prevents deep erosion, protecting the coastal hinterland from severe damage.

290. (A) II, III, I, IV
Coral reef ecosystems are zoned based on depth and wave energy from the open ocean landward. The sequence begins with the deep fore-reef slope. This rises to the shallow reef crest, which absorbs the highest wave impact. This is followed by the shallow reef flat, and finally transitions into the sheltered back-reef lagoon.

291. (A) Sea-level rise leading to inundation and saltwater intrusion into aquifers
Rising sea levels pose an imminent existential threat to low-lying coral atoll nations. Deeper tidal waters lead to chronic coastal flooding and shoreline erosion. Furthermore, sea-level rise drives saltwater intrusion into fragile freshwater lenses, contaminating drinking water aquifers and agricultural soils, making these island nations uninhabitable long before they are submerged.

292. (A) Propagules develop on the parent to draw nutrients and avoid osmotic stress
Vivipary in mangroves is a highly specialized reproductive adaptation where the embryo germinates and develops into a seedling while still attached to the parent tree. This continuous connection allows the seedling to draw water and nutrients from the parent, bypassing the extreme salinity and unstable sediment conditions of the surrounding intertidal mud.

293. (A) Expulsion of pigmented zooxanthellae revealing the underlying white skeleton
The white appearance of bleached corals occurs due to the breakdown of their symbiotic relationship with zooxanthellae. Under environmental stress, corals expel these pigmented microalgae or the algae lose their photosynthetic pigments. This loss leaves the living coral tissue transparent,

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(C) Coral bleaching
(D) Calcification failure

2009
34. The oxygen- and capacity-limited thermal tolerance (OCLTT) hypothesis suggests that a fish's thermal tolerance is primarily constrained by:
(A) Loss of neuromuscular control systems
(B) Oxygen supply cardiorespiratory capacity
(C) Thermal protein denaturation processes
(D) Rapid depletion of intracellular glycogen

2022
35. Phenological shifts in aquatic ecosystems refer specifically to changes in the:
(A) Spatial distribution of species
(B) Genetic diversity of populations
(C) Trophic levels of apex predators
(D) Timing of recurring biological events

2025
36. Which species is known to undergo significant poleward range shifts in response to warming ocean temperatures?
(A) Atlantic cod
(B) Deep-sea anglerfish
(C) Hydrothermal vent tube worms
(D) Antarctic krill

2013
37. High-altitude cold-water aquatic habitats are highly vulnerable to climate change because they:
(A) Lack sufficient solar radiation
(B) Are naturally hyper-saline
(C) Have no space for species to migrate upward
(D) Support low levels of dissolved oxygen naturally

2019
38. A lower carbon footprint in seafood production is typically associated with which type of fishing gear?
(A) Purse seines for small pelagics
(B) Industrial benthic dredges
(C) Non-selective bottom trawls
(D) Mechanized longline systems

2012
39. Mangroves sequester high amounts of carbon primarily due to:
(A) Rapid oceanic circulation flushing detritus
(B) High rates of aerobic decomposition
(C) The presence of pneumatophores absorbing direct atmospheric CO_2
(D) Slow decomposition rates in waterlogged, anaerobic soils

2023
40. Consider the following statements regarding the Shared Socioeconomic Pathways (SSPs):
I. They describe future scenarios of socio-economic development.
II. They are entirely independent of greenhouse gas emissions.
III. They were introduced in the IPCC Fifth Assessment Report (AR5).
IV. SSP5 represents fossil-fueled development.
Which of the above statements are INCORRECT?
(A) I and IV
(B) II and III
(C) I and II
(D) III and IV

2002
41. The primary objective of the UNFCCC is to:
(A) Global poverty eradication via fisheries
(B) Total elimination of active gear types
(C) Greenhouse gas stabilization in the air
(D) Global marine protected area networks

2008
42. Earth System Models (ESMs) differ from standard Global Circulation Models (GCMs) primarily by explicitly incorporating:
(A) Atmospheric pressure variations over time
(B) Sea surface temperature anomalies in basins
(C) Periodic solar radiation cycles and flux
(D) Biogeochemical carbon cycles

2022
43. Species Distribution Models (SDMs) predict future biogeographical range shifts using which primary input data?
(A) Occurrence data and environmental variables
(B) Population-level gene flow rates
(C) In-situ predator-prey trophic dynamics
(D) Historical commercial fishing statistics

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2004
44. Adaptive capacity in a fisheries community depends on all of the following EXCEPT:
(A) Access to diverse financial capital
(B) Ocean acidification baseline
(C) Local education and training levels
(D) Local governance institution strength

2018
45. Ecological phase shifts in marine ecosystems are most accurately defined as:
(A) Temporary seasonal changes in plankton

CHAPTER 09
Climate Change and Fisheries

2025
1. Which of the following gases exhibits the highest specific Global Warming Potential (GWP) over a 100-year horizon?
(A) Atmospheric methane
(B) Carbon dioxide gas
(C) Sulfur hexafluoride
(D) Nitrous oxide emissions

2005
2. The biological pump in marine systems primarily involves the vertical transport of which form of carbon to the deep ocean?
(A) Dissolved inorganic carbon
(B) Particulate organic carbon
(C) Dissolved organic carbon
(D) Atmospheric carbon monoxide

2012
3. Thermal expansion of seawater contributes significantly to sea-level rise primarily due to changes in which physical parameter?
(A) Sea surface salinity levels
(B) Benthic ocean pressure gradients
(C) Atmospheric carbon concentrations
(D) Water molecule kinetic energy

2018
4. In the context of global ocean circulation, what drives the thermohaline circulation?
(A) Temperature and salinity gradients
(B) Surface wind stress patterns
(C) Lunar tidal force interactions
(D) The Coriolis effect alone

2017
5. During the El Niño phase of ENSO, which atmospheric feature exhibits significant disruption leading to weakened trade winds?
(A) Hadley Cell dynamics
(B) Polar Vortex strength
(C) Walker Circulation
(D) Ferrel Cell circulation

2004
6. The Indian Ocean Dipole (IOD) positively impacts pelagic fisheries in the western Indian Ocean during its positive phase due to which phenomenon?
(A) Enhanced regional upwelling
(B) Deepening of the thermocline
(C) Downwelling of nutrient-rich water
(D) Suppression of surface winds

2021
7. The dissolution of anthropogenic CO_2 in seawater initially forms which weak acid?
(A) Sulfuric acid
(B) Hydrochloric acid
(C) Nitric acid
(D) Carbonic acid

2021
8. A reduction in the aragonite saturation state under ocean acidification most immediately threatens which physiological process in pteropods?
(A) Respiration
(B) Calcification
(C) Photosynthesis
(D) Osmoregulation

2008
9. Which metric is most commonly used to predict mass coral bleaching events based on accumulated thermal stress?
(A) Sea Surface Salinity Anomaly
(B) Ocean Heat Content (OHC)
(C) Degree Heating Weeks (DHW)
(D) Photosynthetically Active Radiation (PAR)

2003
10. The Q10 temperature coefficient measures the change in a biological rate over what temperature interval?
(A) 1 degree Celsius
(B) 5 degrees Celsius
(C) 10 degrees Celsius
(D) 15 degrees Celsius

2015
11. Cushing's match-mismatch hypothesis primarily explains fluctuations in fish population recruitment based on what factor?
(A) Larval hatching and bloom timing

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which clearly reveals the stark white calcium carbonate skeleton beneath.

294. (A) Highly lignified, rigid trunks resembling terrestrial trees to withstand wave action
Seagrasses are true marine angiosperms possessing subterranean rhizomes, true root networks, and internal aerenchyma tissue for buoyancy. However, they lack highly lignified, rigid trunks. Instead, they have evolved highly flexible, ribbon-like leaves designed to bend easily with incoming waves and water currents, minimizing physical drag and mechanical damage.

295. (A) Both A and R are true and R is the correct explanation of A.
Establishing Marine Protected Areas often faces strong opposition from local artisanal fishers. Strict no-take zones displace traditional communities from their historical fishing grounds, causing short-term economic hardship and food insecurity. To ensure long-term conservation success, planners must actively engage local stakeholders and provide alternative, sustainable coastal livelihoods.

296. (A) Rapid shoot elongation in response to burial and deep root systems for moisture
Pioneer psammophytes in coastal sand dunes employ specialized physiological adaptations to survive. To prevent being buried by shifting sand, they exhibit rapid shoot elongation. Additionally, they develop highly extensive, deep root networks to access moisture in dry sandy substrates, while waxy, thick leaves minimize desiccation from wind and sun.

297. (A) Chilika Lake
Chilika Lake in Odisha is a Ramsar site renowned for its complex hydrology. During the monsoon, massive freshwater runoff from rivers transforms the lake into a low-salinity freshwater system. In the dry season, reduced river flow allows seawater to dominate, turning the lake into a highly saline lagoon, supporting diverse seasonal biodiversity.

298. (C) An approximately 1:1 ratio of males to females
The sex of marine turtle hatchlings is determined by temperature-dependent mechanisms. The pivotal temperature is the specific incubation temperature that produces an equal sex ratio. Clutches incubated at this thermal threshold yield approximately equal proportions of male and female offspring, whereas even minor deviations skew the ratio toward one sex.

299. (A) Using cyanide to stun fish while simultaneously poisoning surrounding polyps
Cyanide fishing is a destructive harvesting practice that causes severe ecological damage to coral reefs. Fishers squirt sodium cyanide into reef crevices to stun valuable aquarium fish. This chemical is highly toxic, killing non-target organisms and poisoning the surrounding coral polyps, leading to widespread reef mortality and ecosystem collapse.

300. (A) Coastal communities, traditional fishers, industry representatives, and local government
Successful Integrated Coastal Zone Management depends on comprehensive stakeholder participation. It is essential to engage local coastal communities, traditional fishers, industry representatives, and local municipal governments. This inclusive governance ensures that coastal management plans are socially equitable, minimize user conflicts, and achieve high compliance with conservation regulations.

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2023
23. The implementation of weather early warning systems for coastal fishing communities is classified as which type of climate response?
(A) Mitigation
(B) Geoengineering
(C) Sequestration
(D) Adaptation

2019
24. Match the Climate Concepts in List I with their Descriptions in List II.
List I: (Climate Concept)
P. GWP
Q. DHW
R. RCP
S. LCA
List II: (Description)
1. Thermal stress metric
2. Emissions trajectory
3. Warming impact ratio
4. Environmental footprint assessment
(A) P-I, Q-II, R-III, S-IV
(B) P-III, Q-I, R-II, S-IV
(C) P-IV, Q-III, R-II, S-I
(D) P-II, Q-IV, R-I, S-III

2009
25. Which phenomenon explains the trapping of outgoing infrared radiation by certain atmospheric gases?
(A) Albedo effect
(B) Coriolis effect
(C) Greenhouse effect
(D) Ekman transport

2002
26. The solubility pump is most efficient at removing CO_2 from the atmosphere in which regions?
(A) Warm equatorial waters
(B) Tropical upwelling zones
(C) Shallow coastal estuaries
(D) High-latitude cold waters

2023
27. Increased ocean stratification due to surface warming has what primary effect on marine primary production?
(A) Restricting nutrient transport to the photic zone
(B) Vertical mixing and nutrient availability enhancement
(C) Complete elimination of the deep chlorophyll maximum
(D) Acceleration of the sinking rate of phytoplankton

2011
28. The great ocean conveyor belt completes one full cycle roughly over what time scale?
(A) 1 to 10 years
(B) 10 to 50 years
(C) 100 to 200 years
(D) 1000 to 2000 years

2016
29. During La Niña, the trade winds over the equatorial Pacific Ocean are characterized as:
(A) Weaker than normal
(B) Stronger than normal
(C) Completely reversed
(D) Unchanged from normal

2017
30. Consider the following statements regarding the Pacific Decadal Oscillation (PDO):
I. It operates on a time scale of 20 to 30 years.
II. It only affects the Atlantic Ocean.
III. Its warm phase enhances coastal upwelling off North America.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I only

2008
31. The reduction in ocean pH alters the speciation of dissolved inorganic carbon, specifically causing a decrease in the concentration of:
(A) Dissolved CO_2
(B) Carbonic acid
(C) Carbonate ions
(D) Bicarbonate ions

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2002
32. Which of the following is an INCORRECT statement regarding the impacts of ocean acidification?
(A) It increases the metabolic cost of calcification.
(B) It decreases the acoustic absorption of low-frequency sound in seawater.
(C) It alters the olfaction capabilities in some larval reef fishes.
(D) It universally enhances the calcification rates of all crustacean species.

2022
33. The breakdown of the symbiotic relationship between corals and Symbiodiniaceae is definitively known as:
(A) Coral necrosis
(B) Black band disease

(A) $CO_2 + O_2 \rightarrow CO_4$
(B) $CaCO_3 + H_2O \rightarrow Ca(OH)_2 + CO_2$
(C) $HCO_3^- + H^+ \rightarrow H_2CO_4$
(D) $CO_2 + H_2O \rightarrow H_2CO_3$

2021
56. Select the correct order of the Intergovernmental Panel on Climate Change (IPCC) Assessment Reports from oldest to newest.
(A) AR5, TAR, FAR, SAR, AR6
(B) FAR, SAR, TAR, AR4, AR5, AR6
(C) SAR, FAR, TAR, AR5, AR4, AR6
(D) TAR, FAR, AR4, SAR, AR5, AR6

2023
57. Which metric specifically determines the susceptibility of calcium carbonate structures to dissolution in seawater?
(A) Alkalinity to salinity ratio
(B) Total dissolved solids
(C) Saturation state (Ω)
(D) Redfield ratio

2025
58. In the context of coral physiology, which event is the primary cellular trigger for the expulsion of symbionts during heat stress?
(A) Excess carbon sequestration
(B) Symbiodiniaceae uptake processes
(C) Photoprotection mechanism failure
(D) Reactive Oxygen Species (ROS) accumulation

2009
59. The metabolic scope for growth in fish is calculated as the difference between:
(A) Active metabolic rate and resting metabolic rate
(B) Total energy intake and energy lost to excretion
(C) Maximum critical temperature and minimum critical temperature
(D) Somatic growth rate and gonadal growth rate

2002
60. Match the Climatic Phenomena in List I with their Regions of Impact in List II.
List I: (Climatic Phenomenon)
P. ENSO
Q. IOD
R. PDO
S. NAO
List II: (Region of Impact)
1. Indian Ocean
2. North Atlantic
3. Equatorial Pacific
4. North Pacific
(A) P-III, Q-I, R-IV, S-II
(B) P-I, Q-III, R-II, S-IV
(C) P-III, Q-IV, R-I, S-II
(D) P-II, Q-I, R-IV, S-III

2006
61. The concept of "tropicalization" of temperate marine environments primarily involves:
(A) The introduction of artificial heating systems
(B) Poleward expansion of tropical species
(C) Increased frequency of intense tropical cyclones
(D) Destruction of existing coral reefs in the tropics

2010
62. Estuaries are highly sensitive to climate change primarily because they face concurrent risks from:
(A) Sea-level rise and altered river discharge
(B) Tectonic uplift and local volcanism events
(C) Increased glaciation and lowered salinity levels
(D) Desertification and permafrost melt impacts

2018
63. Which assessment methodology comprehensively evaluates the environmental impacts of a fishery product from extraction to final consumption?
(A) Ecological Risk Assessment
(B) Maximum Sustainable Yield (MSY) calculation
(C) Life Cycle Assessment (LCA)
(D) Biomass dynamic modeling

2016
64. Seagrass meadows mitigate climate change locally by:
(A) Increasing water temperature through solar absorption
(B) Emitting methane gas into the water column
(C) Releasing high concentrations of carbonic acid
(D) Elevating pH via carbon uptake

2005
65. The Shared Socioeconomic Pathways (SSPs) used in IPCC AR6 replace which previous scenario framework?
(A) Representative Concentration Pathways
(B) Kyoto Annex I emission targets
(C) Special Report on Emissions Scenarios
(D) Clean Development Mechanism projects

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abundance
(B) Abrupt transitions between structural states
(C) Diurnal vertical migrations of mesopelagic fish
(D) Gradual genetic adaptations to increasing salinity

2001

46. The transition from active trawling to passive trapping gears contributes to climate mitigation by:
(A) Reducing fossil fuel consumption per unit catch
(B) Decreasing the bycatch of protected species
(C) Increasing the metabolic rates of target fish
(D) Altering the albedo of the ocean surface

2025

47. Climate-smart fisheries management integrates which three core dimensions?
(A) Profitability, subsidization, and expansion
(B) Aquaculture, capture fisheries, and mariculture
(C) Mitigation, adaptation, and sustainable yield
(D) Privatization, quota trading, and deregulation

2006

48. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:
Assertion (A): The National Action Plan on Climate Change (NAPCC) in India incorporates strategies for coastal zone management.
Reason (R): Coastal zones are immune to the impacts of sea-level rise due to their dynamic sediment transport.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2022

49. Nitrous oxide (N_2O) is a potent greenhouse gas primarily released into aquatic environments via:
(A) Geochemical carbonate dissolution
(B) Breakdown of ocean microplastics
(C) Runoff-driven denitrification processes
(D) Respiration of various marine mammals

2007

50. Consider the following statements concerning the global carbon cycle:
I. The ocean holds significantly less carbon than the atmosphere.
II. Phytoplankton fix CO_2 through photosynthesis.
III. The deep ocean acts as a major carbon sink.
IV. Calcareous ooze forms from sinking foraminifera shells.
V. Riverine input of dissolved carbon is negligible to marine systems.
Which of the above statement(s) is/are correct?
(A) I, II and III
(B) II, III and IV
(C) III, IV and V
(D) I, IV and V

2004

51. Sea surface temperature (SST) anomalies are calculated by comparing current temperatures against:
(A) Maximum historical temperatures
(B) Deep ocean bottom temperatures
(C) Continental air temperatures
(D) A long-term average climatology

2021

52. Which surface current is the largest wind-driven current on Earth and links the Atlantic, Indian, and Pacific Oceans?
(A) Antarctic Circumpolar Current
(B) North Atlantic Gulf Stream
(C) Western Pacific Kuroshio Current
(D) Southwestern Indian Agulhas Current

2004

53. The deepening of the oceanic thermocline in the eastern Pacific during El Niño results in:
(A) Enhanced nutrient upwelling off South America
(B) Lower sea levels along the Peruvian coast
(C) Reduced nutrient upwelling off South America
(D) Increased primary productivity in the Galápagos

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2004

54. The Peruvian anchoveta fishery frequently collapses during strong El Niño events primarily due to:
(A) Nutrient upwelling suppression
(B) Increased incidence of viral disease
(C) Sudden cooling of surface water layers
(D) Hypoxic conditions in the water column

2019

55. The formula for the formation of carbonic acid in the ocean is best represented by:

2025
76. The largest active pool of carbon in the global carbon cycle is found in the:
(A) Terrestrial biosphere
(B) Deep ocean
(C) Atmosphere
(D) Sedimentary rocks

2012
77. Which process describes the physical transfer of CO_2 from the atmosphere to the ocean's surface layer?
(A) Biological pump
(B) Air-sea gas exchange
(C) Carbonate dissolution
(D) Oceanic subduction

2006
78. Sea-level rise caused by the melting of grounded ice sheets is an example of which type of change?
(A) Eustatic sea-level rise
(B) Steric sea-level rise
(C) Isostatic rebound
(D) Thermal expansion

2018
79. The sinking of dense, cold, and saline water in the North Atlantic is a critical driver of the:
(A) North Atlantic Oscillation patterns
(B) Surface Ekman spiral mechanics
(C) Atlantic Meridional Overturning Circulation
(D) Equatorial countercurrent dynamics

2023
80. Identify the INCORRECT statement regarding the Walker circulation.
(A) It is an east-west atmospheric circulation cell over the equatorial Pacific.
(B) It involves rising air over the warmer western Pacific.
(C) It is driven by zonal sea surface temperature gradients.
(D) It strengthens significantly during El Niño events.

2009
81. Upwelling suppression during El Niño is detrimental to fisheries because it cuts off the supply of:
(A) Dissolved oxygen concentrations
(B) Warm surface water layers
(C) Nitrate and phosphate nutrients
(D) Suspended particulate plastics

2016
82. Which measurement parameter is directly measured to determine the ocean's pH level?
(A) Concentration of hydroxide ions
(B) Activity of hydrogen ions
(C) Concentration of calcium ions
(D) Partial pressure of oxygen

2017
83. The saturation state (Ω) of calcite is generally higher than that of aragonite because:
(A) Aragonite is less soluble in seawater than calcite.
(B) Aragonite contains magnesium, which inhibits dissolution.
(C) Calcite forms strictly in deep oceanic trenches.
(D) Calcite is less soluble in seawater than aragonite.

2016
84. Coral bleaching severity is closely linked to which environmental stressor alongside elevated temperature?
(A) High solar irradiance
(B) Low solar irradiance
(C) Excessive dissolved oxygen
(D) Decreased water clarity

2009
85. According to the thermal tolerance window concept, pejus temperatures are those at which:
(A) Occurrence of optimal growth rates
(B) Immediate protein denaturation causing death
(C) Decline in cardiorespiratory capacity
(D) Entry into a state of complete hibernation

2005
86. Which factor is considered a reliable cue for initiating migration in many aquatic species, yet remains largely unaltered by climate change?
(A) Photoperiod
(B) Temperature
(C) Salinity
(D) Phytoplankton concentration

2003
87. Match the Model Types in List I with their Primary Functions in List II.
List I: (Model Type)
P. GCM
Q. SDM
R. EwE
S. LCA
List II: (Primary Function)
1. Predicting habitat shifts
2. Assessing supply chain emissions
3. Simulating global climate systems

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2001

66. The Paris Agreement aims to keep the global temperature increase well below what threshold above pre-industrial levels?
(A) 1.0 °C
(B) 1.5 °C
(C) 2.0 °C
(D) 3.0 °C

2024

67. Which type of climate downscaling utilizes empirical relationships between large-scale atmospheric variables and local climate?
(A) Dynamical downscaling
(B) Deterministic downscaling
(C) Mechanistic downscaling
(D) Statistical downscaling

2003

68. Coupled physical-biological models are essential for understanding climate impacts because they integrate:
(A) Ocean physics and biogeochemical cycles
(B) Genetic drift with various morphological traits
(C) Terrestrial runoff with ozone layer depletion
(D) Economic markets with commercial fisheries yield

2017

69. Qualitative vulnerability assessments in fisheries typically rely heavily on:
(A) Complex systems of differential equations
(B) Remote sensing satellite data collection
(C) Expert judgment and stakeholder inputs
(D) Automated genomic sequencing techniques

2002

70. Arrange the biological responses to progressive ocean warming in the sequence they typically occur for an individual fish.
I. Shift in biogeographical range
II. Onset of cellular stress mechanisms (e.g., Heat Shock Proteins)
III. Mild metabolic rate increase
IV. Mortality due to cardiorespiratory failure
(A) III, II, I, IV
(B) II, III, I, IV
(C) III, I, II, IV
(D) I, III, II, IV

2007

71. Ecological resilience is most accurately defined as the capacity of an ecosystem to:
(A) Remaining entirely unchanged under environmental stress
(B) Maximizing biodiversity regardless of local conditions
(C) Rapidly adapting through genetic mutation processes
(D) Absorbing disturbances while retaining structure

2024

72. Reducing the idle time of fishing vessels and utilizing LED lights instead of incandescent bulbs in squid jigging are examples of:
(A) Adaptation strategies
(B) Mitigation strategies
(C) Geoengineering strategies
(D) Vulnerability assessments

2021

73. Diversification of livelihoods in coastal communities aims to directly improve which component of vulnerability?
(A) Climate exposure
(B) Environmental sensitivity
(C) Adaptive capacity
(D) Radiative forcing

2024

74. FAO guidelines for climate change adaptation in fisheries emphasize an "ecosystem approach to fisheries" (EAF), which prioritizes:
(A) Single-species maximum sustainable yield targets
(B) Ignoring human social systems in management plans
(C) Exclusive use of highly mechanized fishing fleets
(D) Balancing ecosystem and human well-being

2010

75. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:
Assertion (A): The global warming potential (GWP) of methane is higher than that of carbon dioxide.
Reason (R): Methane remains in the atmosphere for thousands of years, far longer than carbon dioxide.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

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(B) Commercial overharvesting rates
(C) Spawning habitat availability
(D) Adult fish species competition

2017

12. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:
Assertion (A): Climate change is causing the tropicalization of temperate marine ecosystems.
Reason (R): Tropical marine species are expanding their ranges poleward as sea surface temperatures increase.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

13. Which coastal ecosystem is typically found in temperate latitudes and plays a major role in blue carbon sequestration?
(A) Mangrove forests
(B) Salt marshes
(C) Coral reefs
(D) Kelp forests

2012

14. In life cycle assessments (LCA) of capture fisheries, which fishing method generally exhibits the highest fuel intensity per unit of catch?
(A) Bottom trawling
(B) Pelagic longlining
(C) Purse seining
(D) Passive gillnetting

2015

15. The long-term carbon sequestration in blue carbon ecosystems primarily occurs in which compartment?
(A) Above-ground biomass
(B) Pelagic fish biomass
(C) Anaerobic sediment pools
(D) Dissolved inorganic carbon in water

2019

16. Which Working Group of the Intergovernmental Panel on Climate Change (IPCC) assesses the vulnerability of socio-economic and natural systems to climate change?
(A) Working Group I
(B) Working Group III
(C) Task Force on National Greenhouse Gas Inventories
(D) Working Group II

2002

17. The Clean Development Mechanism (CDM) was a core component of which international climate agreement?
(A) Paris Agreement
(B) Montreal Protocol
(C) Kyoto Protocol
(D) Convention on Biological Diversity

2022

18. Which technique is used to translate large-scale Global Circulation Model (GCM) outputs to higher-resolution regional scales?
(A) Upscaling
(B) Downscaling
(C) Extrapolation
(D) Interpolation

2025

19. Ecopath with Ecosim (EwE) is a modeling suite primarily used to analyze which aspect of aquatic systems?
(A) Ocean fluid dynamics modeling
(B) Atmospheric carbon cycling patterns
(C) Single-species genetic drift analysis
(D) Food web mass-balance

2009

20. In climate vulnerability frameworks, the degree to which a system is affected, either adversely or beneficially, by climate stimuli is defined as:
(A) Sensitivity
(B) Exposure
(C) Adaptive capacity
(D) Resilience

2016

21. When a coral reef ecosystem transitions permanently into a macroalgae-dominated state due to thermal stress, it has crossed a:
(A) Carrying capacity
(B) Maximum sustainable yield
(C) Tipping point
(D) Trophic cascade

2017

22. Which modification to fishing operations is considered a direct climate change mitigation strategy?
(A) Improving vessel engine fuel efficiency
(B) Shifting target species based on abundance
(C) Installing weather early warning systems
(D) Diversifying fisher livelihood incomes

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4. Modeling aquatic food webs
(A) P-I, Q-III, R-IV, S-II
(B) P-III, Q-I, R-IV, S-II
(C) P-III, Q-IV, R-I, S-II
(D) P-II, Q-I, R-III, S-IV

2023
88. Boreal and polar marine species face higher extinction risks under climate change primarily because they:
(A) Exceptionally high thermal tolerance limits
(B) Inability to migrate to colder habitats
(C) Possession of high levels of genetic variability
(D) Continuous reproduction throughout the entire year

2005
89. Salt marshes mitigate climate change through carbon sequestration, a process heavily reliant on the presence of:
(A) Calcifying organisms
(B) Deep-sea upwelling
(C) Halophytic vegetation
(D) Chemosynthetic bacteria

2011
90. Identify the INCORRECT pair related to carbon footprint mitigation in fisheries.
(A) Hull cleaning - Reduces hydrodynamic drag
(B) Speed reduction - Exponentially decreases fuel use
(C) Solar panels on vessels - Decreases auxiliary diesel usage
(D) Kite rigs on trawls - Increases fuel consumption

2018
91. The term "blue carbon" was first officially highlighted in international environmental policy to emphasize the role of:
(A) Coastal vegetated ecosystems
(B) Open ocean phytoplankton
(C) Benthic crustacean shells
(D) Deep-sea methane hydrates

2005
92. Representative Concentration Pathways (RCPs) are defined primarily by their predicted:
(A) Predicted economic GDP growth rates
(B) Radiative forcing values in 2100
(C) Annual fishery harvest quota levels
(D) Rate of global human population decline

2013
93. Carbon trading mechanisms aim to reduce global emissions by:
(A) Banning all fossil fuel use immediately
(B) Market-based cost-effective reductions
(C) Taxing exclusively the commercial fisheries
(D) Mandating identical cuts for every country

2018
94. Statistical downscaling of climate models relies heavily on the assumption of:
(A) Stationarity of statistical relationships
(B) Constant atmospheric pressure systems globally
(C) Uniform biological responses to temperature
(D) Perfect accuracy of short-term weather forecasts

2006
95. In Species Distribution Modeling (SDM), environmental niche prediction is often based on the principles of:
(A) Competitive exclusion mechanics
(B) Island biogeography theory
(C) Hutchinson's niche principles
(D) The Red Queen hypothesis

2023
96. Consider the following elements typically included in a vulnerability assessment framework:
I. Exposure
II. Economic profitability
III. Sensitivity
IV. Adaptive capacity
Which of the above statement(s) is/are correct?
(A) I, II and III
(B) I, III and IV
(C) II, III and IV
(D) I, II and IV

2004
97. Hysteresis in ecological resilience indicates that:
(A) Ecosystems revert instantly once stressors are removed
(B) Genetic diversity guarantees total ecosystem stability
(C) Return path requires different conditions
(D) Phase shifts are purely a mathematical artifact

NODIA

2013
98. Decarbonization of a fishing fleet most directly involves:
(A) Throwing less bycatch back into the ocean
(B) Alternative propulsion fuel transition
(C) Increasing the mesh size of various fishing nets
(D) Subsidizing fuel costs for artisanal fishermen

2019

99. Modification of fishing seasons as an adaptation strategy primarily helps to counteract:
(A) Increased vessel fossil fuel costs
(B) Incidental bycatch of protected species
(C) Accumulation of biofouling on vessel hulls
(D) Shifting fish phenology and spawning

2024

100. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:
Assertion (A): The adoption of disaster risk reduction (DRR) in coastal fisheries includes the implementation of mangrove afforestation.
Reason (R): Mangroves provide a natural buffer against storm surges and coastal erosion.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2013

101. Which greenhouse gas is exclusively synthetic and purely of anthropogenic origin?
(A) Carbon dioxide
(B) Methane
(C) Chlorofluorocarbons (CFCs)
(D) Nitrous oxide

2006

102. The "microbial carbon pump" in the ocean refers to the process where:
(A) Large whales sink to the bottom and sequester carbon
(B) Microbes convert labile dissolved organic carbon into recalcitrant forms
(C) Bacteria decompose all organic matter into CO_2 within 24 hours
(D) Plankton only exist in the surface 1 meter of the water column

2017

103. Sea-level rise disproportionately threatens coastal aquaculture infrastructure through which mechanism?
(A) Decreasing wave energy
(B) Lowering coastal groundwater tables
(C) Increasing estuarine dissolved oxygen
(D) Saltwater intrusion into freshwater ponds

2002

104. Surface wind-driven oceanic currents are significantly deflected by the Earth's rotation, an effect described mathematically by:
(A) Newton's second law
(B) The Coriolis parameter
(C) The Stefan-Boltzmann law
(D) Bernoulli's principle

2014

105. ENSO phase transitions are strongly coupled with subsurface oceanic temperature anomalies known as:
I. Tsunami waves
II. Tidal bores
III. Rossby waves and Kelvin waves
IV. Rogue waves
(A) I and II
(B) III only
(C) IV only
(D) I and IV

2005

106. The Pacific Decadal Oscillation (PDO) primarily influences marine ecosystems in the:
(A) North Atlantic
(B) Tropical Indian Ocean
(C) Southern Ocean
(D) North Pacific

2021

107. Identify the INCORRECT statement regarding the chemistry of ocean acidification.
(A) Increased hydrogen ion concentration raises the ocean pH.
(B) Hydration of CO_2 produces carbonic acid.
(C) Carbonic acid dissociates into bicarbonate and hydrogen ions.
(D) Excess hydrogen ions react with carbonate ions to form more bicarbonate.

2021

108. Pteropods are highly vulnerable to ocean acidification because their shells are composed of:
(A) High-magnesium calcite
(B) Aragonite
(C) Low-magnesium calcite
(D) Silica

2003

109. Degree Heating Weeks (DHW) accumulate thermal stress when the sea surface temperature exceeds the maximum monthly mean by at least:
(A) 0.5 °C
(B) 1.0 °C

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(C) 2.0 °C
(D) 5.0 °C

2013
110. Arrange the following marine habitats in order of their typical carbon sequestration capacity per hectare per year, from highest to lowest.
(A) Salt marshes, Mangroves, Open ocean
(B) Mangroves, Salt marshes, Open ocean
(C) Open ocean, Salt marshes, Mangroves
(D) Mangroves, Open ocean, Salt marshes

2010
111. The phenomenon where predators fail to synchronize their life cycle with peak prey abundance due to shifting environmental cues is called:
(A) Trophic cascade
(B) Competitive exclusion
(C) Phenological mismatch
(D) Biomagnification

2012
112. The migration of marine species to deeper waters in response to warming is an attempt to track:
(A) Increased light availability
(B) Higher salinity gradients
(C) Lower pressure zones
(D) Isotherms

2015
113. Seagrass ecosystems are vulnerable to climate-induced sea-level rise primarily due to:
(A) Enhanced nutrient upwelling
(B) Overgrazing by dugongs
(C) Increased light attenuation from deeper water
(D) Decreased tidal flushing

2004
114. The Life Cycle Assessment (LCA) phase that quantifies the total emissions and resource usage is called:
(A) Goal and Scope definition
(B) Life Cycle Inventory (LCI)
(C) Impact assessment
(D) Interpretation

2005
115. Identify the correct pair representing a major blue carbon sink and its primary latitudinal zone.
(A) Mangroves - Polar regions
(B) Seagrasses - Exclusively high-altitude lakes
(C) Coral reefs - Abyssal plains
(D) Salt marshes - Temperate regions

2007
116. The IPCC operates under the auspices of the World Meteorological Organization (WMO) and which other UN body?
(A) United Nations Environment Programme (UNEP)
(B) World Health Organization (WHO)
(C) Food and Agriculture Organization (FAO)
(D) International Maritime Organization (IMO)

2024
117. The Kyoto Protocol specifically established binding emission reduction targets for:
(A) All developing nations
(B) Small island developing states
(C) Annex I (developed) countries
(D) Non-governmental organizations

2001
118. Which statement best defines a Global Circulation Model (GCM)?
(A) A mathematical representation of planetary atmospheric and oceanic processes
(B) A purely statistical model predicting daily local weather
(C) A qualitative assessment tool for fisheries vulnerability
(D) An economic model of global fish trade

2011
119. In modeling climate impacts on fisheries, coupled physical-biological models solve equations for:
(A) Genetic mutation rates and natural selection pressures
(B) Capital depreciation and market demand
(C) Satellite orbit trajectories and telemetry
(D) Fluid dynamics and biogeochemical tracers simultaneously

2008
120. Consider the following factors that increase a fishery's sensitivity to climate change:
I. High reliance on a single target species
II. Diverse, multi-gear fishing fleets
III. Target species with narrow thermal tolerance
IV. Extensive use of deep-sea trawl nets
Which of the above statement(s) is/are correct?
(A) I and II
(B) I and III
(C) II and IV
(D) III and IV

2007
121. Ecological thresholds are points at which:
(A) A population reaches maximum sustainable yield

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(D) Oceanic plastic pollution

2021

143. The Clean Development Mechanism (CDM) allowed developed countries to meet emission reduction targets by:
(A) Relocating their heavily polluting industries to the ocean
(B) Eliminating all capture fisheries globally
(C) Investing in emission-reduction projects in developing countries
(D) Purchasing marine protected areas

2004

144. Dynamical downscaling in climate modeling relies on:
(A) Extrapolating historical catch data
(B) Applying simple statistical regressions to global averages
(C) Surveying local fishers regarding weather patterns
(D) Using high-resolution Regional Climate Models (RCMs) driven by GCM boundary conditions

2022

145. Ecopath with Ecosim (EwE) incorporates climate forcing by allowing environmental variables to directly influence:
(A) The genetic mutation rate of top predators
(B) The speed of ocean currents
(C) Foraging capacities and primary production rates
(D) The tectonic movement of ocean basins

2006

146. Which vulnerability assessment methodology uses a matrix to score the likelihood and consequence of climate impacts?
(A) Life Cycle Assessment
(B) Risk Assessment Matrix
(C) Maximum Likelihood Estimation
(D) Fourier Transform Analysis

2024

147. A "phase shift" in a coral reef ecosystem typically involves the transition from coral dominance to dominance by:
(A) Sponges
(B) Sea anemones
(C) Coralline algae
(D) Fleshy macroalgae

2005

148. Mitigation of post-harvest greenhouse gas emissions in fisheries can be effectively achieved by:
(A) Shifting transport from air freight to maritime shipping
(B) Increasing the use of polystyrene packaging
(C) Lowering the freezing temperatures of storage units unnecessarily
(D) Extending the supply chain geographically

2009

149. Climate-smart fisheries management strongly advocates for:
(A) Rigid, inflexible harvest quotas
(B) Subsidizing high-emission fishing vessels
(C) Adaptive management and dynamic seasonal closures
(D) Ignoring traditional ecological knowledge

2002

150. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:
Assertion (A): The adoption of circular economy principles in fisheries reduces the sector's overall carbon footprint.
Reason (R): Circular economy minimizes waste and maximizes the valorization of fish by-products, reducing the need for raw material extraction.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

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2006

151. Which greenhouse gas is produced biologically in aquatic systems under anaerobic conditions, such as in stagnant wetlands?
(A) Sulfur hexafluoride
(B) Ozone
(C) Chlorofluorocarbons
(D) Methane

2021

152. Identify the INCORRECT statement regarding the biological pump.
(A) It involves phytoplankton utilizing dissolved CO_2 for photosynthesis.
(B) It is driven entirely by the physical cooling of surface waters.
(C) It transports organic carbon from the photic zone to the ocean interior.

2004

132. The process of ocean acidification results in a reduction of which biologically critical ion?
(A) $CO_3^{\{2-\}}$
(B) Na^+
(C) Cl^-
(D) HCO_3^-

2018

133. Coral reefs are highly sensitive to acidification primarily because their framework is constructed of:
(A) Chitin
(B) Silica
(C) Aragonite
(D) Cellulose

2023

134. Which phenomenon most directly triggers the expulsion of zooxanthellae from coral tissues?
(A) Production of toxic reactive oxygen species (ROS) in symbionts due to heat
(B) Rapid decrease in seawater salinity during monsoons
(C) Ingestion of microplastics by coral polyps
(D) Excessive growth of macroalgae on the reef crest

2023

135. As water temperature increases, the dissolved oxygen saturation point in aquatic systems:
(A) Increases linearly
(B) Remains constant
(C) Increases exponentially
(D) Decreases

2023

136. The match-mismatch hypothesis highlights the importance of spatial and temporal overlap between:
(A) Apex predators and their competitors
(B) Fish larvae and their zooplankton prey
(C) Adult fish and optimal spawning substrates
(D) Fishing vessels and target shoals

2025

137. Tropicalization often leads to the decline of native temperate species primarily due to:
(A) Direct thermal mortality only
(B) Complete loss of oceanic salinity
(C) Increased competition and predation from range-expanding tropical species
(D) Reduced light penetration

2024

138. High-altitude aquatic ecosystems are uniquely vulnerable to climate change due to:
(A) Intense upwelling currents
(B) Ocean acidification impacts on freshwater corals
(C) Saltwater intrusion into alpine lakes
(D) Rapid glacial retreat altering hydrological regimes

2004

139. In evaluating the carbon footprint of fisheries, the use of ice and refrigeration onboard vessels contributes primarily to:
(A) Indirect emissions (Scope 2 or 3)
(B) Direct emissions (Scope 1)
(C) Ecosystem metabolism
(D) Bycatch mortality

2018

140. Match the International Agreements in List I with their Core Focus in List II.
List I: (International Agreement)
P. UNFCCC
Q. Kyoto Protocol
R. Paris Agreement
S. IPCC
List II: (Core Focus)
1. Scientific assessment
2. Binding targets for developed nations
3. Framework for global climate action
4. NDCs and 1.5°C target
(A) P-III, Q-II, R-IV, S-I
(B) P-I, Q-III, R-II, S-IV
(C) P-IV, Q-I, R-III, S-II
(D) P-II, Q-IV, R-I, S-III

2001

141. Blue carbon sequestration in mangroves is highly effective largely because:
(A) Mangrove leaves are highly reflective, increasing albedo
(B) The anoxic nature of mangrove sediments prevents rapid carbon remineralization
(C) Mangroves respire oxygen instead of carbon dioxide
(D) Tides wash all carbon into the deep abyssal plain immediately

2009

142. The Representative Concentration Pathways (RCPs) represent potential future trajectories of:
(A) Radiative forcing driven by greenhouse gas concentrations
(B) Fishery maximum sustainable yields
(C) Global population demographics

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(C) Mitochondrion
(D) Endoplasmic reticulum

2004

185. The "pejus" temperature in the context of fish thermal tolerance refers to the point where:
(A) The fish experiences immediate mortality
(B) Optimum growth rate is achieved
(C) Aerobic scope begins to decline, indicating things are "getting worse"
(D) Reproductive output is maximized

2019

186. Match the Fisheries Impacts in List I with their Underlying Climate Drivers in List II.
List I: (Fisheries Impact)
P. Range shifts
Q. Altered spawning cues
R. Shell dissolution
S. Habitat inundation
List II: (Underlying Climate Driver)
1. Ocean acidification
2. Sea-level rise
3. Phenological changes
4. Ocean warming
(A) P-IV, Q-III, R-I, S-II
(B) P-III, Q-IV, R-I, S-II
(C) P-IV, Q-I, R-III, S-II
(D) P-I, Q-IV, R-II, S-III

2008

187. "Tropicalization" affects temperate macroalgal forests primarily by:
(A) Subjecting them to increased herbivory by range-expanding tropical fish
(B) Enhancing their photosynthetic efficiency
(C) Causing them to calcify rapidly
(D) Increasing nutrient availability

2007

188. Estuaries face a unique vulnerability known as "coastal squeeze" which occurs when:
(A) Freshwater inflow exceeds tidal inflow
(B) Sea-level rise pushes habitats landward against fixed anthropogenic infrastructure
(C) Tidal ranges decrease due to lunar orbit changes
(D) Estuaries become completely sealed by sandbars

2008

189. Which variable is NOT typically included in the Life Cycle Assessment (LCA) of a captured fish?
(A) Fuel consumed during fishing
(B) Natural predation rates of the target species
(C) Refrigerants used in onboard storage
(D) Electricity used during processing and packaging

2012

190. The concept of "additionality" in blue carbon offset projects requires that:
(A) The project sequesters more carbon than would have occurred in its absence
(B) The project utilizes artificial technological carbon capture
(C) The ecosystem is entirely undisturbed by humans historically
(D) Carbon is stored exclusively in above-ground biomass

2018

191. Which of the following statements regarding the Intergovernmental Panel on Climate Change (IPCC) is true?
(A) The IPCC funds major field experiments.
(B) The IPCC operates its own climate satellites.
(C) The IPCC assesses scientific literature but does not conduct its own original research.
(D) The IPCC only conducts original economic research.

NODIA

2005

192. Which mechanism under the Kyoto Protocol was designed to facilitate technology transfer and emission reductions in developing nations?
(A) Joint Implementation
(B) Emissions Trading
(C) Green Climate Fund
(D) Clean Development Mechanism (CDM)

2004

193. Downscaling techniques are required to bridge the gap between GCMs and local fisheries models because GCMs typically have a spatial resolution of:
(A) 1-5 km
(B) 10-50 km
(C) 100-300 km
(D) 1000-5000 km

2016

194. In the Ecopath model, mass balance is achieved when production of a functional group equals:
(A) Total solar irradiance − Respiration
(B) Predation mortality + Catch + Other mortality + Biomass accumulation + Export
(C) Assimilation efficiency × Consumption
(D) Primary production + Import

(D) It includes the downward flux of marine snow.

2010

153. Sea-level rise threatens estuarine ecosystems primarily by causing:
(A) Decreased tidal ranges
(B) Increased freshwater discharge
(C) Upstream saltwater intrusion and habitat inundation
(D) Lowering of the estuarine turbidity maximum

2021

154. Surface ocean currents are primarily generated by:
(A) Geothermal vents
(B) Salinity gradients between the poles and equator
(C) The gravitational pull of the moon
(D) Global wind patterns transferring momentum to the sea surface

2022

155. During a strong La Niña event, the thermocline in the eastern equatorial Pacific is:
(A) Shallower than normal
(B) Deeper than normal
(C) Disrupted completely by deep convection
(D) Unchanged

2004

156. Arrange the following stages of ocean acidification modeling in the correct sequence.
I. Projection of atmospheric CO_2 emissions
II. Calculation of changes in seawater pH and saturation state
III. Air-sea gas exchange rate estimation
IV. Assessment of biological impact on calcifiers
(A) I, III, II, IV
(B) I, II, III, IV
(C) III, I, II, IV
(D) II, I, IV, III

2003

157. Identify the correct pair regarding ocean pH changes.
(A) Current ocean pH - Approximately 8.5
(B) Pre-industrial ocean pH - Approximately 8.2
(C) Projected pH by 2100 (RCP8.5) - Approximately 8.8
(D) Pre-industrial ocean pH - Approximately 7.5

2010

158. The metabolic cost of maintaining calcification under acidified conditions often leads to which biological trade-off in marine molluscs?
(A) Reduced somatic growth and reproductive output
(B) Increased shell thickness
(C) Enhanced immune system response
(D) Accelerated swimming speeds

2004

159. Degree Heating Weeks (DHW) are calculated by accumulating temperature anomalies over what continuous time period?
(A) 2 weeks
(B) 4 weeks
(C) 12 weeks
(D) 24 weeks

2019

160. Consider the following statements regarding fish thermal physiology:
I. Fish are predominantly endothermic.
II. Oxygen demand increases with rising temperatures up to the critical maximum.
III. Aerobic scope is maximized at the critical thermal maximum.
IV. High temperatures can cause enzyme denaturation.
Which of the above statement(s) is/are correct?
(A) I and III
(B) II and IV
(C) I and II
(D) III and IV

2016

161. Cushing's match-mismatch hypothesis is most applicable to the study of:
(A) Adult fish migration
(B) Benthic nutrient cycling
(C) Larval fish survival and recruitment
(D) Bycatch reduction device efficiency

2008

162. Deep-water shifts of marine species are primarily an adaptation to avoid:
(A) High surface irradiance
(B) Warming surface temperatures
(C) Surface predators
(D) Ocean acidification, which is worse at the surface

2022

163. Mangroves, salt marshes, and seagrasses are collectively referred to as "blue carbon" ecosystems. Which trait do they share?
(A) They are entirely freshwater habitats.
(B) They grow exclusively in polar regions.
(C) They do not require light for growth.
(D) They consist of angiosperms adapted to

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(B) Climate change impacts become completely reversible
(C) Small environmental changes cause rapid and disproportionate ecological responses
(D) Fish achieve sexual maturity

2012
122. The implementation of fuel taxes or carbon pricing in the fisheries sector is an economic policy designed to incentivize:
(A) Overcapitalization
(B) Bycatch retention
(C) Habitat degradation
(D) Climate change mitigation

2015
123. The development of saline-tolerant aquaculture species is a direct response to which climate-induced threat?
(A) Sea-level rise and saltwater intrusion
(B) Ocean acidification
(C) Deoxygenation
(D) Increased storm frequency

2025
124. National Action Plans on Climate Change (NAPCC) of India includes specific core missions. How many national missions were originally launched under this plan?
(A) Four
(B) Six
(C) Eight
(D) Ten

2011
125. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:
Assertion (A): The solubility of carbon dioxide in seawater decreases as ocean temperature rises.
Reason (R): Gases are generally less soluble in warmer liquids due to increased kinetic energy of the molecules.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2010
126. Which metric accounts for both the radiative efficiency of a greenhouse gas and its atmospheric lifetime?
(A) Global Warming Potential
(B) Carbon Footprint
(C) Ocean Heat Content
(D) Albedo Feedback

2006
127. Thermal expansion of the oceans is scientifically termed:
(A) Isostatic expansion
(B) Eustatic sea-level rise
(C) Steric sea-level rise
(D) Halosteric adjustment

NODIA

2022
128. What primarily limits the efficiency of the biological pump in the oligotrophic open ocean?
(A) Excess dissolved oxygen
(B) High partial pressure of CO_2
(C) Intense vertical mixing
(D) Nutrient limitation (e.g., iron, nitrogen)

2017
129. Thermohaline circulation is driven by density differences. Density in seawater is highest when the water is:
(A) Warm and fresh
(B) Warm and saline
(C) Cold and saline
(D) Cold and fresh

2006
130. Consider the following statements concerning the El Niño-Southern Oscillation (ENSO):
I. El Niño involves anomalous warming in the central and eastern equatorial Pacific.
II. La Niña involves anomalous cooling in the same region.
III. ENSO events typically persist for 5 to 7 years.
IV. The Southern Oscillation Index (SOI) measures atmospheric pressure differences between Tahiti and Darwin.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, III and IV
(C) II, III and IV
(D) I, II and III

2003
131. The Indian Ocean Dipole (IOD) is a coupled ocean-atmosphere phenomenon characterized by anomalous SST gradients between the:
(A) Northern and Southern Indian Ocean
(B) Indian Ocean and the Pacific Ocean
(C) Indian Ocean and the Southern Ocean
(D) Western and Eastern equatorial Indian Ocean

2013

175. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:
Assertion (A): Global Circulation Models (GCMs) provide exact, pinpoint weather forecasts for local fishing grounds decades into the future.
Reason (R): GCMs are designed to simulate long-term climatic trends over large spatial scales rather than short-term local weather.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2017

176. Which greenhouse gas is released from marine oxygen minimum zones primarily through the process of denitrification?
(A) CO_2
(B) CH_4
(C) Water vapor
(D) N_2O

2025

177. "Deep ocean ventilation" refers to the process where:
(A) Dissolved oxygen is consumed by benthic organisms
(B) Carbon dioxide is released from hydrothermal vents
(C) Cold, oxygen-rich surface waters sink and spread across the ocean floor
(D) Shallow lagoons evaporate into the atmosphere

2012

178. Sea-level rise impacts nearshore fisheries primarily by:
(A) Increasing pelagic primary production
(B) Altering or degrading critical nursery habitats like estuaries and mangroves
(C) Lowering coastal salinity globally
(D) Increasing the clarity of coastal waters

2012

179. The Coriolis effect deflects moving water to the right in the Northern Hemisphere and to the left in the Southern Hemisphere, leading to the formation of:
(A) Equatorial countercurrents
(B) Deep ocean trenches
(C) Hydrothermal vents
(D) Subtropical oceanic gyres

2015

180. Consider the following statements concerning the Indian Ocean Dipole (IOD):
I. During a positive IOD, sea surface temperatures drop in the western Indian Ocean.
II. A positive IOD is associated with increased rainfall in East Africa.
III. It can operate independently of ENSO.
IV. It strongly influences the Indian summer monsoon.
Which of the above statement(s) is/are correct?
(A) II, III and IV
(B) I, II and III
(C) I, III and IV
(D) I, II and IV

2007

181. Upwelling zones are highly productive but are naturally prone to which stressor that is exacerbated by climate change?
(A) Extreme hypersalinity
(B) High temperatures
(C) Low pH and low dissolved oxygen
(D) Nutrient depletion

2016

182. Ocean acidification lowers the saturation state of calcium carbonate. Which saturation state value (Ω) indicates corrosive conditions where dissolution begins?
(A) $\Omega > 1$
(B) $\Omega = 1$
(C) $\Omega < 1$
(D) $\Omega = 0$ only

2024

183. Which class of marine organism is highly vulnerable to acidification due to its extensive use of high-magnesium calcite?
(A) Teleost fish
(B) Marine mammals
(C) Cephalopods
(D) Echinoderms

2018

184. Coral bleaching primarily involves the disruption of photosynthesis within Symbiodiniaceae. Which cellular organelle is most directly damaged by thermal stress in this process?
(A) Nucleus
(B) Chloroplast (specifically photosystem II)

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coastal, saline environments.

2011

164. In a Life Cycle Assessment (LCA) of pelagic longlining, the most significant greenhouse gas emissions typically originate from:
(A) Marine diesel combustion during fishing operations
(B) Production of steel hooks
(C) Manufacturing of monofilament lines
(D) End-of-life disposal of the vessel

2002

165. The loss of blue carbon ecosystems is particularly concerning for climate change because:
(A) It reduces global albedo
(B) It stops the biological pump in the open ocean
(C) It releases centuries of stored carbon back into the atmosphere or water column
(D) It increases the ocean's pH rapidly

2009

166. Working Group I of the IPCC is specifically tasked with assessing:
(A) The physical science basis of climate change
(B) Vulnerability and adaptation
(C) Mitigation of climate change
(D) International climate finance

2019

167. The primary goal of the UNFCCC, adopted at the Rio Earth Summit in 1992, was to:
(A) End all commercial fishing globally
(B) Mandate solar power for all maritime vessels
(C) Create a single global currency for carbon trading
(D) Prevent dangerous anthropogenic interference with the climate system

2013

168. Statistical downscaling is generally computationally faster than dynamical downscaling but relies on the assumption of:
(A) Perfect atmospheric mixing
(B) Stationary climate relationships over time
(C) Complete absence of cloud cover
(D) Constant solar radiation

2005

169. Species Distribution Models (SDMs) typically utilize which algorithm to predict future habitats based on presence-only data?
(A) Ordinary Least Squares (OLS) regression
(B) Fast Fourier Transform (FFT)
(C) Maximum Entropy (MaxEnt)
(D) Principal Component Analysis (PCA) alone

NODIA

2024

170. Which equation best defines vulnerability in the context of IPCC climate frameworks?
(A) $\text{Vulnerability} = \text{Exposure} + \text{Sensitivity}$
(B) $\text{Vulnerability} = \dfrac{\text{Adaptive Capacity}}{\text{Exposure}}$
(C) $\text{Vulnerability} = \text{Mitigation} + \text{Adaptation}$
(D) $\text{Vulnerability} = (\text{Exposure} + \text{Sensitivity}) - \text{Adaptive Capacity}$

2010

171. A tipping point in an aquatic ecosystem signifies:
(A) A critical threshold where a small change causes a rapid shift to a new ecosystem state
(B) A minor, reversible change in species abundance
(C) The maximum depth to which sunlight penetrates
(D) The peak of a population cycle

2017

172. Which of the following gears is classified as "passive" and generally exhibits a lower carbon footprint?
(A) Bottom otter trawl
(B) Traps and pots
(C) Pelagic midwater trawl
(D) Dredge

2007

173. Climate-smart aquaculture adaptation strategies include all EXCEPT:
(A) Selective breeding for thermal tolerance
(B) Implementing integrated multi-trophic aquaculture (IMTA)
(C) Upgrading infrastructure to withstand extreme weather
(D) Expanding single-species intensive farming in highly vulnerable coastal zones

2018

174. The FAO emphasizes disaster risk reduction (DRR) in fisheries. Which is a key component of a DRR strategy?
(A) Early warning systems for extreme weather events
(B) Increasing fleet capacity
(C) Removing coastal vegetation to improve vessel access
(D) Centralizing all fishing operations to a single port

2019

195. Adaptive capacity in a vulnerability assessment is generally considered to be a function of:
(A) Geographic latitude
(B) The depth of the local thermocline
(C) The specific heat capacity of water
(D) Socio-economic factors like wealth, technology, and institutions

2002

196. The maintenance of high biodiversity in aquatic ecosystems generally enhances:
(A) Ecological resilience
(B) Climate exposure
(C) Greenhouse gas emissions
(D) The likelihood of tipping point crossings

2011

197. Which of the following practices constitutes a climate-smart mariculture strategy?
(A) Moving pens to deeper, cooler offshore waters
(B) Increasing the stocking density of sensitive species
(C) Using HFC refrigerants with the highest GWP
(D) Removing all coastal mangroves to build ponds

2021

198. Weather early warning systems are critical for adapting to which climate change impact?
(A) Increased frequency and intensity of extreme weather events
(B) Gradual ocean acidification
(C) Deoxygenation
(D) Phenological mismatches

2024

199. The FAO's Code of Conduct for Responsible Fisheries incorporates climate adaptation by promoting:
(A) Maximizing fishing effort in unassessed stocks
(B) Subsidizing larger fishing vessels
(C) Disregarding bycatch limits during heatwaves
(D) Precautionary approaches to management

2005

200. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:
Assertion (A): Marine protected areas (MPAs) can serve as an adaptation tool against climate change.
Reason (R): MPAs can protect critical habitats and refugia, enhancing overall ecosystem resilience to climatic stressors.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2008

201. Which greenhouse gas accounts for the largest percentage of the anthropogenic greenhouse effect globally?
(A) Methane
(B) Nitrous oxide
(C) Carbon dioxide
(D) Halocarbons

2014

202. The transfer of carbon from the atmosphere to the ocean is driven by the difference in:
(A) Salinity
(B) Coriolis force
(C) Lunar gravity
(D) Partial pressure of CO_2 (pCO_2) between the air and sea surface

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2004

203. Which mechanism primarily drives local sea-level fall in regions like Scandinavia and northern Canada, masking global sea-level rise?
(A) Glacial isostatic adjustment (rebound)
(B) Thermal contraction
(C) Enhanced evaporation
(D) Tectonic subsidence

2010

204. The Atlantic Meridional Overturning Circulation (AMOC) is predicted to weaken under climate change due to:
(A) Increased surface salinity from evaporation
(B) Freshening of the North Atlantic from melting Greenland ice
(C) Strengthening of the trade winds
(D) Deepening of the Mediterranean Sea

2003

205. The Southern Oscillation Index (SOI) is calculated based on the standardized sea level pressure difference between:
(A) Hawaii and Tokyo
(B) Tahiti and Darwin
(C) Lima and Sydney
(D) Reykjavik and Lisbon

2019
206. Which climatic oscillation is primarily characterized by sea surface temperature anomalies in the North Pacific and has phases lasting 20-30 years?
(A) PDO
(B) ENSO
(C) NAO
(D) IOD

2013
207. Ocean acidification alters marine acoustic environments by:
(A) Increasing the absorption of low-frequency sound
(B) Blocking high-frequency echolocation entirely
(C) Decreasing the absorption of low-frequency sound, making the ocean noisier
(D) Having no physical effect on sound propagation

2007
208. Identify the correct statement regarding biological impacts of acidification on non-calcifying organisms.
(A) It has no effect on any non-calcifying organisms.
(B) It universally enhances the growth of all marine phytoplankton.
(C) It causes immediate physical dissolution of fish scales.
(D) It can alter neurotransmitter function, impairing olfaction and behavior in fish.

2004
209. Degree Heating Weeks (DHW) value greater than 8 typically indicates:
(A) Optimal conditions for coral growth
(B) Mild bleaching expected
(C) Widespread bleaching and significant mortality likely
(D) Complete recovery of bleached corals

2005
210. Which group of fishes typically exhibits the narrowest thermal tolerance window?
(A) Eurythermal estuarine fish
(B) Antarctic Notothenioids
(C) Tropical reef fish
(D) Temperate coastal fish

2016
211. Which term describes the trend of decreasing dissolved oxygen levels in the ocean due to warming and increased stratification?
(A) Ocean Acidification
(B) Ocean Deoxygenation
(C) Eutrophication
(D) Pelagic Squeeze

2017
212. Identify the INCORRECT statement regarding climate-driven biogeographical shifts.
(A) Range shifts only occur latitudinally, never bathymetrically.
(B) Pelagic species generally shift ranges faster than benthic species.
(C) Barriers to movement (e.g., landmasses) restrict range expansion.
(D) The trailing edge of a species' range may experience local extinctions.

2022
213. High-altitude lakes are experiencing warming at rates often exceeding global averages, a phenomenon related to:
(A) High local ocean acidification
(B) Intense coastal squeeze
(C) Elevation-dependent warming
(D) Saltwater intrusion

2025
214. In LCA of seafood, the "functional unit" is typically defined as:
(A) One specific fishing vessel
(B) The total oceanic carbon sink
(C) A quantified amount of product (e.g., 1 tonne of landed catch)
(D) The entire fishing fleet

2003
215. What is the approximate range of annual carbon burial rates in seagrass meadows compared to terrestrial forests?
(A) 10-40 times higher per hectare
(B) 10-40 times lower per hectare
(C) Exactly the same
(D) Seagrasses do not bury carbon

2008
216. The IPCC's Shared Socioeconomic Pathway SSP1 is characterized by:
(A) High inequality and fossil-fueled development
(B) Sustainability and low challenges to mitigation and adaptation
(C) Regional rivalry and nationalism
(D) Rapid economic growth driven exclusively by coal

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2023
217. The primary market-based mechanism established to price carbon emissions globally is:
(A) The Command-and-Control standard
(B) The Exclusive Economic Zone (EEZ)
(C) Emissions Trading Systems (Cap-and-Trade)
(D) Total Allowable Catch (TAC)

2021
218. In modeling, Earth System Models (ESMs) improve upon GCMs by explicitly closing the:
(A) Hydrological cycle
(B) Nitrogen cycle only
(C) Orbital cycle
(D) Carbon cycle

2012
219. Species Distribution Models (SDMs) are sometimes criticized because they primarily rely on:
(A) Correlative relationships between species presence and environmental variables
(B) Complex physiological equations
(C) Real-time genetic sampling
(D) In-situ manipulation experiments

2021
220. Consider the following steps in a standard climate vulnerability assessment for fisheries:
I. Define the scope and objectives
II. Assess exposure and sensitivity
III. Assess adaptive capacity
IV. Implement immediate geoengineering
V. Calculate vulnerability index
Which of the above statement(s) is/are correct?
(A) I, II, III and V
(B) I, II, IV and V
(C) II, III, IV and V
(D) I, III, IV and V

2005
221. Coral reefs transitioning to algal dominance following severe bleaching and storm damage represent a shift in:
(A) Salinity regimes
(B) Ecological phase or regime
(C) Tectonic plates
(D) Orbital forcing

2001
222. Energy audits on fishing vessels typically identify which system as the primary consumer of fossil fuels?
(A) Main propulsion engine
(B) Navigation electronics
(C) Onboard lighting
(D) Hydraulic winches

2008
223. Livelihood diversification in coastal fisheries is an adaptation strategy designed to:
(A) Increase dependency on a single highly variable fish stock
(B) Maximize carbon emissions
(C) Reduce socio-economic vulnerability to climate-induced fishery failures
(D) Eliminate all capture fishing

2014
224. India's NAPCC outlines the National Mission for Sustaining the Himalayan Ecosystem, which addresses climate impacts on:
(A) Tropical coral reefs
(B) Deep-sea hydrothermal vents
(C) Mangrove afforestation
(D) High-altitude aquatic and terrestrial habitats

2003
225. The greenhouse gas with the highest concentration in the atmosphere is:
(A) Carbon dioxide
(B) Methane
(C) Water vapor
(D) Nitrous oxide

2006
226. The "solubility pump" operates most strongly in regions where surface waters become:
(A) Warmer and less dense
(B) Colder and more dense
(C) Hypersaline due to evaporation only
(D) Highly stratified

2008
227. Sea-level rise is measured globally using which specific satellite technology?
(A) Synthetic Aperture Radar (SAR)
(B) Multispectral Imaging
(C) Infrared Thermography
(D) Satellite Altimetry

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2023
228. Wind-driven Ekman transport in the ocean surface layer moves water at what angle to the wind direction in the Northern Hemisphere?
(A) 45 degrees to the left
(B) 45 degrees to the right
(C) 90 degrees to the left
(D) 90 degrees to the right

(A) Developing nations emit no greenhouse gases
(B) Their vulnerability is high while historical emissions are relatively low
(C) Mitigation is free of cost
(D) Adaptation prevents all climate impacts entirely

2009

297. Which of the following defines the "Representative Concentration Pathways (RCPs)" used in IPCC modeling?
(A) Precise predictions of global economic growth
(B) Legislative mandates for fisheries closures
(C) Scenarios of radiative forcing trajectories up to the year 2100
(D) Historical records of sea-level rise

2025

298. The biological carbon pump efficiency is highly dependent on the "rain ratio," which refers to the relative export of:
(A) Nitrogen to phosphorus
(B) Freshwater to saltwater
(C) Dissolved oxygen to dissolved carbon dioxide
(D) Organic carbon to inorganic carbon (calcium carbonate)

2021

299. Changes in the Walker circulation directly govern the onset and intensity of which major climate phenomenon?
(A) El Niño-Southern Oscillation
(B) North Atlantic Oscillation
(C) Pacific Decadal Oscillation
(D) Atlantic Multidecadal Oscillation

2005

300. Which of the following correctly identifies the three main objectives of "climate-smart fisheries"?
(A) Maximizing yield, expanding fleets, and subsidies
(B) Productivity, resilience, and mitigation
(C) Privatization, strict quotas, and fleet reduction
(D) Elimination of bycatch, trawl bans, and mariculture

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socio-economic policies that nations must follow. Reason (R): RCPs are strictly policy-prescriptive frameworks mandated by the United Nations.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) Both A and R are false.

2025
241. The Paris Agreement features a "ratchet mechanism," which means that participating countries must:
(A) Reduce fishing quotas by 10% annually
(B) Pay a fixed international carbon tax
(C) Submit progressively more ambitious Nationally Determined Contributions (NDCs) every five years
(D) Eliminate all diesel engines by 2030

2013
242. Which modeling approach is best suited for assessing the complex trophic interactions and potential cascading effects of climate change on a marine food web?
(A) Single-species surplus production models
(B) Ecopath with Ecosim (EwE)
(C) Virtual Population Analysis (VPA)
(D) Leslie matrix models

2016
243. In downscaling climate models, the use of high-resolution regional grids driven by boundary conditions from a global model is termed:
(A) Statistical downscaling
(B) Empirical orthogonal function analysis
(C) Linear regression
(D) Dynamical downscaling

2010
244. A quantitative vulnerability assessment of a fishery typically integrates:
(A) Biological sensitivity, physical exposure, and socio-economic adaptive capacity indices
(B) Only economic profit margins
(C) Historical catch data alone
(D) Qualitative stakeholder interviews only

2009
245. Resilience in aquatic systems can be eroded by cumulative impacts. Which of the following is a classic example of a cumulative impact?
(A) A single moderate storm
(B) A natural seasonal temperature fluctuation
(C) The combined stress of overfishing, nutrient pollution, and ocean warming
(D) The diurnal tidal cycle

2014
246. Adopting energy-efficient hull designs (e.g., bulbous bows) on fishing vessels is a strategy for:
(A) Mitigation
(B) Adaptation
(C) Eutrophication reduction
(D) Acidification reversal

2011
247. Climate-smart fisheries management requires shifting from static to dynamic spatial management, which involves:
(A) Establishing permanent, immovable marine reserves
(B) Adjusting fishing closures in real-time based on environmental conditions and species distributions
(C) Ignoring spatial boundaries entirely
(D) Managing fisheries based solely on historical baselines

2024
248. The FAO guidelines for climate adaptation strongly advocate for "co-management," which is defined as:
(A) Shared responsibility and authority between government agencies and local resource users
(B) Centralized government control of all fishing assets
(C) Complete privatization of fisheries resources
(D) Management by international NGOs only

2002
249. Which greenhouse gas is heavily associated with the use of synthetic fertilizers in coastal agricultural runoff?
(A) CH_4
(B) SF_6
(C) N_2O
(D) O_3

2012
250. The carbon sink capacity of the ocean is expected to decrease as temperatures rise because:
(A) Phytoplankton photosynthesis completely stops in warm water
(B) Increased stratification enhances mixing
(C) Corals calcify faster in warmer water
(D) The solubility of CO_2 in water decreases with increasing temperature

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2008

229. A prolonged period of negative Sea Surface Temperature anomalies in the central and eastern Pacific is termed:
(A) El Niño
(B) Positive IOD
(C) La Niña
(D) Negative NAO

2012

230. Arrange the climatic phenomena primarily by their typical operational time scale, from shortest to longest duration.
I. El Niño event
II. Pacific Decadal Oscillation (PDO)
III. Milankovitch cycles
(A) I, II, III
(B) II, I, III
(C) III, II, I
(D) I, III, II

2015

231. The term "ocean acidification" technically refers to a decrease in pH, meaning the ocean is becoming:
(A) An acid ($pH < 7$)
(B) More alkaline
(C) Pure water (pH exactly 7)
(D) Less alkaline, moving towards neutrality

2008

232. Which of the following is NOT a consequence of reduced carbonate ion concentration in seawater?
(A) Decreased calcification rates in corals
(B) Enhanced formation of marine halite (salt)
(C) Dissolution of existing aragonite shells
(D) Weakened structural integrity of pteropod shells

2001

233. In the context of coral bleaching, what does the acronym "PAR" stand for, which interacts with thermal stress?
(A) Partial Aragonite Reduction
(B) Peak Acclimation Rate
(C) Photosynthetically Active Radiation
(D) Primary Autotrophic Respiration

2025

234. According to the principle of oxygen- and capacity-limited thermal tolerance (OCLTT), fish death at critical thermal maxima is primarily caused by:
(A) Lack of food
(B) Predation
(C) Reproductive failure
(D) Collapse of aerobic energy generation

2003

235. The "match-mismatch" dynamics in fisheries are highly sensitive to:
(A) Differential temperature responses between trophic levels
(B) Lunar cycles
(C) Vessel traffic density
(D) Magnetic field variations

2012

236. The expansion of the geographical range of the lionfish into the western Atlantic is an example of a biological invasion potentially facilitated by:
(A) Ocean cooling
(B) Ocean warming and altered current patterns
(C) Decreased salinity
(D) Increased ocean acidity

2010

237. Which of the following stressors is uniquely problematic for high-altitude cold-water fisheries under climate change?
(A) Coral bleaching
(B) Reduced snowmelt and altered river discharge regimes
(C) Mangrove deforestation
(D) Oceanic deep-water upwelling

2016

238. In a fisheries Life Cycle Assessment, the term "Scope 1 emissions" refers to:
(A) Direct emissions from owned or controlled sources (e.g., vessel fuel)
(B) Indirect emissions from purchased electricity
(C) All indirect emissions in the value chain
(D) Biogenic carbon emissions from fish respiration

2009

239. The preservation of blue carbon ecosystems is often incorporated into national climate strategies under which UNFCCC mechanism?
(A) Clean Development Mechanism only
(B) The Montreal Protocol
(C) Reducing Emissions from Deforestation and Forest Degradation (REDD+)
(D) The Basel Convention

2013

240. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:
Assertion (A): The IPCC's Representative Concentration Pathways (RCPs) dictate specific

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2014

262. In a fisheries LCA, the transition from active gears (like trawls) to passive gears (like longlines) generally results in:
(A) Lower fuel consumption and reduced carbon footprint
(B) Higher fuel consumption and emissions
(C) Complete elimination of bycatch
(D) No change in emissions

2001

263. Blue carbon ecosystems sequester carbon rapidly. The majority of this carbon is ultimately stored in:
(A) The leafy canopy
(B) Herbivorous fish
(C) Calcareous shells
(D) Waterlogged, anaerobic soils

2021

264. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:
Assertion (A): The IPCC Fifth Assessment Report (AR5) introduced the Representative Concentration Pathways (RCPs).
Reason (R): RCPs are scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2021

265. The Kyoto Protocol was adopted in 1997, but the Paris Agreement superseded it to implement a framework where:
(A) Only developed countries reduce emissions
(B) Emissions are ignored in favor of geoengineering
(C) All countries submit Nationally Determined Contributions (NDCs)
(D) The UN determines exact quotas for every country

2002

266. Which type of model is best suited to simulate the physical oceanography (currents, temperature, salinity) on a global scale?
(A) Ecopath with Ecosim
(B) Species Distribution Model (SDM)
(C) Bioeconomic Model
(D) Global Circulation Model (GCM)

2010

267. Identifying the physical limits of a species based on environmental data and projecting these limits geographically is the core principle of:
(A) Species Distribution Modeling (SDM)
(B) Dynamical downscaling
(C) Life Cycle Assessment (LCA)
(D) Mass-balance modeling

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2019

268. In climate vulnerability assessments, the term "Exposure" refers to:
(A) The internal fragility of a system
(B) The presence of people, livelihoods, or assets in places that could be adversely affected
(C) The ability of a community to reorganize after a disaster
(D) The market price of fish after a coral bleaching event

2016

269. A system that can absorb shocks and maintain its basic structure and function exhibits high:
(A) Vulnerability
(B) Resilience
(C) Exposure
(D) Brittleness

2014

270. Utilizing waste heat from fishing vessel engines to generate onboard electricity is a form of:
(A) Fleet decarbonization / Mitigation
(B) Climate adaptation
(C) Bioaccumulation
(D) Overcapitalization

2005

271. An adaptation strategy for inland fisheries facing altered hydrological cycles (e.g., prolonged dry seasons) is:
(A) Stocking thermally sensitive species
(B) Increasing the use of diesel pumps
(C) Deepening aquaculture ponds to maintain water volume
(D) Harvesting all fish before maturity

2013

272. Disaster Risk Reduction (DRR) frameworks in coastal fisheries prioritize:
(A) Post-disaster reactive funding only
(B) Ignoring traditional knowledge systems
(C) Maximizing coastal development
(D) Preparedness, early warning, and building resilient infrastructure

2022

251. Isostatic sea-level changes are distinct from eustatic changes because they are:
(A) Localized vertical movements of the Earth's crust
(B) Driven solely by thermal expansion
(C) Global in scale
(D) Caused by melting glaciers

2011

252. Match the Ocean Circulations in List I with their Primary Drivers in List II.
List I: (Ocean Circulation)
P. Thermohaline Circulation
Q. Surface Gyres
R. Equatorial Upwelling
S. Coastal Upwelling
List II: (Driver)
1. Trade winds divergence
2. Density gradients
3. Wind and Coriolis force
4. Wind parallel to coast
(A) P-II, Q-III, R-I, S-IV
(B) P-III, Q-II, R-IV, S-I
(C) P-II, Q-I, R-III, S-IV
(D) P-I, Q-IV, R-II, S-III

2012

253. The suppression of the Walker circulation during El Niño leads to:
(A) Increased rainfall in Indonesia and Australia
(B) Drought conditions in Indonesia and Australia
(C) Enhanced upwelling off the coast of Peru
(D) Stronger trade winds

2014

254. The collapse of the Peruvian anchoveta fishery during El Niño is a classic example of:
(A) Bottom-up control driven by climate variability
(B) Top-down control by apex predators
(C) Competitive exclusion by invasive species
(D) A pure density-dependent population crash

2010

255. The formula $\Omega = \frac{[Ca^{2+}][CO_3^{2-}]}{K'_{sp}}$ defines the:
(A) Total alkalinity of seawater
(B) Biological pump efficiency
(C) Saturation state of calcium carbonate
(D) Carbonic acid dissociation constant

2007

256. Which marine organism is considered an "indicator species" for ocean acidification due to its highly sensitive aragonite shell?
(A) Sea cucumber
(B) Great white shark
(C) Kelp
(D) Pteropod (Limacina helicina)

2003

257. Which metric integrates both the intensity and duration of thermal stress to predict coral bleaching?
(A) Sea Surface Temperature (SST) absolute value
(B) Photosynthetic efficiency (Fv/Fm)
(C) Degree Heating Weeks (DHW)
(D) Oceanic NINO Index (ONI)

2002

258. The narrowing of a fish's thermal tolerance window under hypoxia supports which physiological concept?
(A) The Q10 effect
(B) Oxygen- and Capacity-Limited Thermal Tolerance (OCLTT)
(C) The metabolic theory of ecology
(D) The Arrhenius equation limit

2011

259. A phenological mismatch between Atlantic mackerel larvae and their zooplankton prey can lead to:
(A) Recruitment failure
(B) Increased adult size-at-age
(C) Enhanced genetic diversity
(D) Exceptional year-class strength

2002

260. The phenomenon where temperate marine species are replaced by species from lower latitudes due to warming is termed:
(A) Tropicalization
(B) Borealization
(C) Desertification
(D) Eutrophication

2025

261. Estuaries are highly sensitive to changes in precipitation patterns primarily because these changes alter:
(A) Deep ocean circulation
(B) Tectonic subsidence rates
(C) The salinity gradient and flushing times
(D) Solar irradiance

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(D) Estuaries

2011

285. Mangrove forests exhibit high vulnerability to rapid sea-level rise primarily if they are affected by:
(A) High salinity
(B) Coastal squeeze blocking landward migration
(C) High nutrient input
(D) Excessive tidal flushing

2002

286. In LCA terms, improving vessel fuel efficiency directly reduces:
(A) Global warming potential (GWP) footprint
(B) Eutrophication potential
(C) Ozone depletion potential
(D) Bycatch mortality

2005

287. "Blue carbon" refers strictly to carbon sequestered by:
(A) Open ocean phytoplankton
(B) Terrestrial forests
(C) Coastal and marine vegetated ecosystems
(D) Deep-sea chemosynthetic communities

2023

288. Which of the following defines a core operating principle of the Intergovernmental Panel on Climate Change (IPCC)?
(A) Policy-prescriptive but not policy-relevant
(B) A regulatory body with enforcement powers
(C) A primary research institution conducting fieldwork
(D) Policy-relevant but not policy-prescriptive

2018

289. The ultimate goal of the Paris Agreement is to limit global warming to well below 2°C, preferably to:
(A) 1.0°C
(B) 1.5°C
(C) 0°C
(D) Pre-industrial absolute temperatures

2016

290. Consider the following Earth System Model (ESM) components:
I. Atmospheric circulation
II. Ocean circulation
III. Land surface processes
IV. Biogeochemical cycles
Which of the above statement(s) is/are correct?
(A) I, II and III
(B) I, II, III and IV
(C) II, III and IV
(D) I and IV only

2008

291. Species Distribution Models (SDMs) are fundamentally based on linking species occurrence data with:
(A) Genetic mutation frequencies
(B) Economic market values
(C) Fishing fleet dynamics
(D) Environmental spatial data layers

2001

292. In a vulnerability framework, a community heavily dependent on a single, climate-sensitive fish stock possesses:
(A) High sensitivity
(B) Low exposure
(C) High adaptive capacity
(D) Low resilience

2016

293. Ecological tipping points represent non-linear responses to climate change, meaning that:
(A) Ecosystems change gradually and predictably
(B) Climate variables only increase linearly
(C) A small additional stressor can cause a massive, rapid ecosystem shift
(D) Ecosystems always recover linearly

2014

294. Mitigation in the fisheries sector can be achieved by upgrading onboard refrigeration systems to use:
(A) Natural refrigerants like ammonia or CO_2
(B) Chlorofluorocarbons (CFCs)
(C) Hydrofluorocarbons (HFCs) with high GWP
(D) Freon

2015

295. Arrange the following steps of developing a climate adaptation plan in fisheries in the correct logical sequence.
I. Implement adaptation actions
II. Conduct vulnerability assessment
III. Monitor and evaluate outcomes
IV. Identify adaptation options
(A) II, IV, I, III
(B) IV, II, I, III
(C) II, I, IV, III
(D) I, II, III, IV

2004

296. National Action Plans on Climate Change (NAPCC) in developing nations often emphasize adaptation over mitigation because:

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2002

273. Which of the following protein sources generally has the lowest greenhouse gas (GHG) footprint per kilogram of product?
(A) Beef
(B) Small pelagic fish (e.g., sardines)
(C) Prawns from intensive mariculture
(D) Lamb

2017

274. Which process actively transports carbon against the concentration gradient from the surface to the deep ocean?
(A) Evaporation
(B) The biological pump
(C) Thermal expansion
(D) Isostatic rebound

2024

275. Sea-level rise threatens coastal aquifers primarily through:
(A) Nutrient loading
(B) Decreased hydrostatic pressure
(C) Thermal pollution
(D) Saltwater intrusion

2008

276. Match the Climate Terms in List I with their Processes in List II.
List I: (Term)
P. Albedo
Q. Steric
R. Advection
S. Sequestration
List II: (Process)
1. Horizontal transport of heat/mass
2. Long-term storage of carbon
3. Reflectivity of a surface
4. Density-driven volume change
(A) P-III, Q-IV, R-I, S-II
(B) P-I, Q-II, R-III, S-IV
(C) P-III, Q-I, R-IV, S-II
(D) P-IV, Q-III, R-II, S-I

2009

277. Which of the following is a major threat to beach-nesting marine species (e.g., sea turtles) due to sea-level rise?
(A) Increased availability of nesting sand
(B) Reduction of available nesting area and increased egg inundation
(C) Cooling of the sand, leading to more male hatchlings
(D) Slower tidal currents

2023

278. The Pacific Decadal Oscillation (PDO) is most strongly expressed in which ocean basin?
(A) North Pacific
(B) South Atlantic
(C) North Atlantic
(D) Indian Ocean

2002

279. In ocean carbonate chemistry, the addition of CO_2 causes a shift in the chemical equilibrium that results in an increase of:
(A) Carbonate ions
(B) Bicarbonate ions
(C) Hydroxide ions
(D) Aragonite saturation

NODIA

2008

280. The dissolution of coral reef frameworks is accelerated when the aragonite saturation state (Ω_{arag}) falls below:
(A) 4.0
(B) 3.0
(C) 1.0
(D) 0.0

2005

281. Thermal stress causes coral bleaching via the accumulation of which harmful compounds in the symbiotic algae?
(A) Polycyclic aromatic hydrocarbons (PAHs)
(B) Heavy metals
(C) Reactive Oxygen Species (ROS)
(D) Microcystins

2011

282. The Q10 coefficient for biological processes in fish is typically around:
(A) 0.5 to 1.0
(B) 2.0 to 3.0
(C) 5.0 to 6.0
(D) 10.0

2007

283. Phenological mismatch in marine food webs primarily disrupts the transfer of:
(A) Energy between trophic levels
(B) Genetic material
(C) Dissolved oxygen
(D) Heat

2003

284. As oceans warm, many highly mobile pelagic fish species are shifting their distribution towards:
(A) The equator
(B) Higher latitudes
(C) Shallower coastal waters only

ANSWERS

1. (C) Sulfur hexafluoride
Global warming potential measures the energy absorbed by a greenhouse gas relative to carbon dioxide. Sulfur hexafluoride possesses an exceptionally high warming potential due to its stability, intense infrared absorption capability, and long atmospheric lifetime. This synthetic gas remains in the atmosphere for thousands of years, significantly outperforming other primary greenhouse gases in heat-trapping efficiency.

2. (B) Particulate organic carbon
The biological pump processes carbon in marine ecosystems through primary production by phytoplankton in the photic zone. This carbon is converted into organic matter and vertically exported to the deep ocean primarily as particulate organic carbon, which includes dead organisms, fecal pellets, and marine snow. This transport effectively sequesters atmospheric carbon dioxide in deep marine reservoirs.

3. (D) Water molecule kinetic energy
Thermal expansion of ocean waters occurs as global temperatures rise due to greenhouse gas accumulation. When seawater absorbs heat, the average kinetic energy of its constituent water molecules increases, causing them to move more rapidly and occupy a larger volume. This physical expansion of water volume directly drives a significant portion of global sea-level rise.

4. (A) Temperature and salinity gradients
Thermohaline circulation represents a global system of deep-ocean currents driven by density differences. These density variations are primarily determined by temperature and salinity gradients across different ocean basins. Cold, saline water at high latitudes sinks to the ocean floor, initiating a slow conveyor belt that distributes heat and nutrients around the entire planet.

5. (C) Walker Circulation
The El Niño phase of the El Niño-Southern Oscillation is characterized by anomalous warming of surface waters in the eastern equatorial Pacific. This oceanic change disrupts the zonal atmospheric Walker Circulation, which normally features rising air in the west and sinking air in the east. Consequently, the atmospheric pressure gradient weakens, leading to diminished trade winds.

6. (A) Enhanced regional upwelling
During the positive phase of the Indian Ocean Dipole, strong westerly winds weaken or reverse, causing cooler sea surface temperatures and upwelling in the eastern equatorial Indian Ocean while warming occurs in the west. This enhances regional upwelling along the western boundaries, bringing nutrient-rich deep waters to the surface, boosting primary productivity and pelagic fish populations.

7. (D) Carbonic acid
When anthropogenic carbon dioxide is released into the atmosphere, a significant portion is absorbed by surface ocean waters. Upon dissolving in seawater, carbon dioxide chemically reacts with water molecules to initially form carbonic acid, which is a weak acid. This chemical reaction represents the fundamental first step in the process of ocean acidification.

8. (B) Calcification
Aragonite is a highly soluble polymorph of calcium carbonate utilized by marine organisms such as pteropods to build their shells. Under ocean acidification, the reduction in aragonite saturation state decreases the availability of carbonate ions. This directly impairs the physiological process of calcification, making it energetically costly or impossible for these organisms to maintain structural shells.

9. (C) Degree Heating Weeks (DHW)
Degree Heating Weeks is a thermal metric developed to monitor and predict mass coral bleaching events. It integrates both the intensity of sea surface temperature anomalies and their duration over a rolling twelve-week window. This cumulative thermal stress index serves as a highly reliable predictor of the severity of coral bleaching and subsequent mortality.

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48. (C) A is true but R is false.
India's National Action Plan on Climate Change incorporates coastal zone management strategies to protect vulnerable marine ecosystems and human settlements. However, coastal zones are exceptionally vulnerable to sea-level rise, which causes severe coastal erosion, flooding, and habitat degradation. Therefore, asserting that coastal zones are immune to sea-level rise due to sediment transport is entirely false.

49. (C) Runoff-driven denitrification processes
Nitrous oxide is an extremely potent greenhouse gas with a high warming potential. In aquatic and coastal environments, its release is primarily accelerated by agricultural runoff containing synthetic nitrogen fertilizers. This excess nitrogen undergoes microbial nitrification and denitrification processes in waterlogged soils and oxygen-depleted waters, generating substantial emissions of nitrous oxide into the atmosphere.

50. (B) II, III and IV
The oceans represent a massive carbon sink, holding far more carbon than the atmosphere. Phytoplankton actively fix carbon dioxide via photosynthesis, and their calcareous shells sink to the sea floor to form extensive layers of carbonate ooze. Because riverine carbon inputs also contribute significantly to marine carbon budgets, only statements II, III, and IV are correct.

51. (D) A long-term average climatology
Sea surface temperature anomalies represent deviations from normal temperature baselines. To calculate these anomalies, scientists subtract a long-term historical average, typically calculated over a thirty-year reference period called a climatology, from the current observed temperature. This standardized approach allows researchers to identify significant regional warming trends and track marine heatwaves.

52. (A) Antarctic Circumpolar Current
The Antarctic Circumpolar Current is the most powerful wind-driven ocean current on Earth. Unobstructed by landmasses, it flows continuously eastward around Antarctica, connecting the Atlantic, Pacific, and Indian Ocean basins. This massive current plays a fundamental role in global climate regulation by transporting heat, salt, and carbon across different oceans.

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53. (C) Reduced nutrient upwelling off South America
During El Niño, weakened trade winds allow a warm pool of surface water to move eastward across the equatorial Pacific. This accumulation of warm water deepens the thermocline off the coast of South America. The deepened thermocline prevents cold, nutrient-rich deep waters from reaching the photic zone, significantly reducing upwelling and primary productivity.

54. (A) Nutrient upwelling suppression
The Peruvian anchoveta fishery is highly dependent on coastal upwelling, which supplies nutrient-rich waters that fuel massive phytoplankton blooms. During strong El Niño events, the deepening of the regional thermocline suppresses this upwelling process. This abrupt nutrient depletion collapses primary production, causing widespread starvation, reproductive failure, and southward migration of anchoveta populations.

55. (D) $CO_2 + H_2O \rightarrow H_2CO_3$
Ocean acidification begins when atmospheric carbon dioxide dissolves into surface seawaters. The dissolved gas chemically reacts with water molecules to form carbonic acid, represented by this chemical equation. This weak acid subsequently dissociates into hydrogen ions and bicarbonate ions, driving down the pH of the ocean and altering marine carbonate chemistry.

56. (B) FAR, SAR, TAR, AR4, AR5, AR6
The Intergovernmental Panel on Climate Change publishes comprehensive Assessment Reports that track the evolution of climate science. The correct chronological sequence of these major publications begins with the First Assessment Report, followed by the Second, Third, Fourth, Fifth, and most recently, the Sixth Assessment Report, documenting decades of advancing global scientific consensus.

57. (C) Saturation state (Ω)
The saturation state is a dimensionless chemical metric that determines the thermodynamic propensity for calcium carbonate minerals to precipitate or dissolve in seawater. When this value is greater than one, conditions favor shell formation. When it falls below one, seawater becomes corrosive, accelerating the dissolution of carbonate shells and skeletons of marine organisms.

and energy pathways among different functional groups within a food web. This system allows researchers to simulate the cumulative impacts of fisheries management policies and environmental changes over time.

20. (A) Sensitivity
In standard climate change vulnerability assessment frameworks, sensitivity represents the biological or structural degree to which a system is affected by climatic stimuli. This metric evaluates how a population, habitat, or human community responds to changes in temperature, salinity, or acidification, reflecting its inherent susceptibility to environmental alterations before accounting for adaptive capacity.

21. (C) Tipping point
A tipping point represents a critical ecological threshold where minor environmental perturbations can trigger rapid, non-linear, and often irreversible shifts in ecosystem state. When a coral reef crosses this threshold due to persistent thermal stress or overfishing, it undergoes a phase shift, transitioning permanently into a degraded, macroalgae-dominated community with altered ecological functions.

22. (A) Improving vessel engine fuel efficiency
Climate change mitigation in capture fisheries focuses on reducing the greenhouse gas emissions associated with harvesting operations. Improving the fuel efficiency of vessel engines directly decreases the volume of fossil fuels burned during fishing trips. This technical modification represents a direct mitigation strategy, lowering the carbon footprint of seafood production at the source.

23. (D) Adaptation
Implementing weather early warning systems for coastal fishing communities is classified as a climate adaptation response. Unlike mitigation, which seeks to reduce greenhouse gas emissions, adaptation involves taking active steps to minimize the risks and adverse impacts of climate change. Early warning networks enhance safety, reduce vulnerability, and build community resilience against extreme weather events.

24. (B) P-III, Q-I, R-II, S-IV
Global Warming Potential acts as a warming impact ratio comparing greenhouse gases. Degree Heating Weeks serves as a cumulative thermal stress metric for corals. Representative Concentration Pathways define standardized future emissions trajectories. Life Cycle Assessment provides a comprehensive environmental footprint assessment across a product's entire supply chain, systematically mapping each concept to its functional description.

25. (C) Greenhouse effect
The greenhouse effect is a fundamental physical process where shortwave solar radiation passes through the atmosphere to warm the Earth surface. The resulting longwave infrared radiation emitted by the planet is absorbed and re-radiated by atmospheric gases such as carbon dioxide and water vapor, effectively trapping heat and maintaining global temperatures suitable for life.

26. (D) High-latitude cold waters
The ocean solubility pump operates through physical and chemical processes that transport dissolved inorganic carbon from the surface to the deep ocean. Carbon dioxide is significantly more soluble in colder waters than in warmer waters. Consequently, the sinking of cold, dense water masses in high-latitude regions driving deep-water formation maximizes the efficiency of this carbon sink.

27. (A) Restricting nutrient transport to the photic zone
Rising sea surface temperatures increase the density gradient between the warm surface layer and cold, nutrient-rich deep waters, enhancing ocean stratification. This physical barrier restricts vertical mixing and inhibits the transport of essential macronutrients into the photic zone. Consequently, phytoplankton in the upper ocean experience nutrient limitation, reducing overall primary productivity in marine ecosystems.

28. (D) 1000 to 2000 years
The thermohaline circulation, often called the great ocean conveyor belt, is a global network of deep and shallow ocean currents. Driven by variations in water temperature and salinity, it distributes heat and nutrients across the globe. This massive global circulation system operates on extremely slow timescales, taking roughly one thousand to two thousand years to complete a full cycle.

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projections, researchers can efficiently estimate high-resolution local climate variables for impact assessments.

68. (A) Ocean physics and biogeochemical cycles
Coupled physical-biological models are advanced simulation tools essential for predicting climate impacts on marine ecosystems. These models integrate equations governing ocean physics, such as circulation, temperature, and mixing, with biogeochemical models representing nutrient cycling and primary production. This integration allows scientists to simulate how physical oceanographic changes propagate through marine food webs.

69. (C) Expert judgment and stakeholder inputs
Vulnerability assessments in fisheries can be conducted using qualitative methodologies when quantitative data are scarce. This approach relies on structured expert judgment, stakeholder workshops, and community interviews to evaluate exposure, sensitivity, and adaptive capacity. This qualitative input provides valuable local ecological and socio-economic context for developing targeted community-based climate adaptation strategies.

70. (A) III, II, I, IV
When exposed to progressive ocean warming, an individual fish typically exhibits a predictable sequence of biological responses. Initially, a mild metabolic rate increase occurs as kinetic energy rises. Continued heating triggers cellular stress proteins. To escape stressful conditions, the fish shifts its biogeographical range. If temperatures exceed its critical limits, cardiorespiratory failure leads to mortality.

71. (D) Absorbing disturbances while retaining structure
Ecological resilience represents the capacity of an ecosystem to tolerate, absorb, and recover from environmental disturbances, such as marine heatwaves or extreme storms. A resilient ecosystem can undergo stress while maintaining its core taxonomic structure, functional processes, and feedback loops, preventing a catastrophic transition into a permanently degraded state.

72. (B) Mitigation strategies
Reducing the idle time of fishing vessels and replacing incandescent bulbs with highly efficient LED lights are practical energy-saving measures. These operational modifications directly decrease the consumption of fossil fuels and associated diesel combustion on vessels. Consequently, these practices are classified as climate mitigation strategies because they reduce greenhouse gas emissions.

73. (C) Adaptive capacity
Livelihood diversification within coastal fishing communities is a socio-economic strategy designed to reduce vulnerability to climate change. By developing alternative sources of income outside of capture fisheries, household financial stability is decoupled from fluctuating fish stocks. This diversification directly strengthens the adaptive capacity of the community, enabling households to cope with climate-induced fishery declines.

74. (D) Balancing ecosystem and human well-being
The Food and Agriculture Organization promotes the Ecosystem Approach to Fisheries as a holistic framework for climate change adaptation. This management strategy prioritizes balancing ecological conservation with human well-being and social equity. By managing fisheries as complex social-ecological systems, this approach enhances the resilience of both marine populations and the coastal communities dependent on them.

75. (C) A is true but R is false.
Methane possesses a significantly higher global warming potential than carbon dioxide over a hundred-year timescale, making the assertion correct. However, methane is a relatively short-lived greenhouse gas, remaining in the atmosphere for approximately twelve years, whereas carbon dioxide persists for hundreds to thousands of years. Thus, the accompanying reasoning is scientifically false.

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76. (B) Deep ocean
In the global carbon cycle, carbon is distributed among various active reservoirs, including the atmosphere, terrestrial biosphere, surface ocean, and deep ocean. Among these active pools, the deep ocean is by far the largest, containing tens of thousands of gigatons of dissolved inorganic carbon, which regulates atmospheric carbon dioxide concentrations over millennial timescales.

77. (B) Air-sea gas exchange
The physical transfer of carbon dioxide between the atmosphere and the surface ocean is governed

times are minimized, resulting in very low fuel consumption and carbon emissions per unit of landed catch.

39. (D) Slow decomposition rates in waterlogged, anaerobic soils
Mangrove forests are exceptionally efficient blue carbon sinks, sequestering immense amounts of organic carbon. This carbon storage capacity is primarily driven by the waterlogged, oxygen-depleted nature of their soils. Anaerobic conditions severely restrict the activity of decomposers, preventing the breakdown of organic matter and allowing carbon to remain buried in the sediment for millennia.

40. (B) II and III
Shared Socioeconomic Pathways are scenarios describing alternative socioeconomic developments, and they were introduced during the IPCC Sixth Assessment cycle rather than the Fifth. These pathways are integrated with greenhouse gas emissions and radiative forcing trajectories to project future climate change. Consequently, stating they are independent of emissions or introduced in AR5 is incorrect.

41. (C) Greenhouse gas stabilization in the air
The primary objective of the United Nations Framework Convention on Climate Change is to achieve the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. This international treaty provides a cooperative framework for global climate negotiations, mitigation policies, and adaptation strategies.

42. (D) Biogeochemical carbon cycles
Earth System Models represent a major advancement over standard Global Circulation Models. While GCMs simulate physical atmospheric and oceanic dynamics, ESMs integrate interactive biogeochemical cycles. By modeling the carbon cycle, vegetation dynamics, and chemical feedback loops, ESMs simulate how the biosphere interacts with the atmosphere and ocean, providing more comprehensive climate projections.

43. (A) Occurrence data and environmental variables
Species Distribution Models are mathematical tools used to predict the geographic range of species under changing climates. These models require species occurrence records, such as presence and absence points, paired with environmental spatial layers including temperature, salinity, and depth. By correlating these datasets, SDMs project how habitat suitability shifts geographically under future warming scenarios.

44. (B) Ocean acidification baseline
Adaptive capacity represents the ability of a fishing community to adjust, cope with, and recover from climate change impacts. It is determined by social, economic, and institutional factors such as financial assets, education, and governance strength. The ocean acidification baseline is an environmental stressor or exposure metric rather than a socio-economic determinant of community coping capacity.

45. (B) Abrupt transitions between structural states
Ecological phase shifts represent sudden, persistent transitions of an ecosystem from one stable structural state to another. These non-linear reorganizations occur when cumulative environmental pressures, such as ocean warming or overfishing, push the ecosystem past a critical threshold. A classic example is the rapid conversion of species-rich coral reefs into species-poor, macroalgae-dominated habitats.

46. (A) Reducing fossil fuel consumption per unit catch
Transitioning from active trawling gears to passive gears like traps and pots serves as a highly effective climate mitigation strategy. Active gears require continuous vessel power to drag heavy equipment across the seabed, consuming massive amounts of fuel. Passive gears remain stationary, requiring fuel only for deployment and retrieval, significantly lowering carbon emissions per catch.

47. (C) Mitigation, adaptation, and sustainable yield
Climate-smart fisheries management is an integrated framework designed to address the challenges of climate change. It simultaneously pursues three key objectives: sustainably increasing fisheries productivity and livelihoods, adapting and building resilience of coastal communities to climate impacts, and mitigating climate change by reducing the greenhouse gas emission intensity of seafood production and processing operations.

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10. (C) 10 degrees Celsius
The Q10 temperature coefficient is a physiological dimensionless parameter used to quantify the temperature sensitivity of a chemical or biological reaction. It represents the rate of change of a system as a consequence of increasing the ambient temperature by exactly ten degrees Celsius, serving as a standardized tool to evaluate metabolic shifts in ectothermic organisms.

11. (A) Larval hatching and bloom timing
Cushing's match-mismatch hypothesis explains variability in fish recruitment by examining the temporal overlap between spawning and prey availability. It suggests that survival rates of larval fish depend heavily on the synchronization of their hatching with the seasonal spring phytoplankton and zooplankton blooms. Disruption of this timing due to environmental shifts leads to severe recruitment failures.

12. (A) Both A and R are true and R is the correct explanation of A.
Ocean warming driven by climate change induces significant shifts in marine species distributions. As sea surface temperatures rise, tropical marine species expand their ranges poleward into temperate zones, a phenomenon known as tropicalization. This direct ecological expansion reorganizes temperate communities, making range shifts the primary and scientifically accurate driver of tropicalization in higher latitude ecosystems.

13. (B) Salt marshes
Salt marshes are highly productive coastal wetlands situated predominantly in temperate and high-latitude regions. These ecosystems play a vital role in global carbon cycling by sequestering substantial amounts of organic carbon, commonly referred to as blue carbon, within their waterlogged, anaerobic soils, where decomposition is extremely slow, preserving carbon for centuries or millennia.

14. (A) Bottom trawling
Life cycle assessments of capture fisheries consistently show that different harvesting techniques have varying environmental footprints. Bottom trawling requires vessels to drag heavy nets along the seafloor, creating immense hydrodynamic drag. This mechanical resistance demands substantial engine power, resulting in the highest fuel consumption intensity and associated greenhouse gas emissions per unit of landed catch.

15. (C) Anaerobic sediment pools
Long-term carbon sequestration in coastal blue carbon ecosystems occurs predominantly within underground reservoirs rather than living biomass. The waterlogged, anaerobic conditions of these estuarine and marine sediments significantly inhibit the aerobic decomposition of organic matter. Consequently, organic carbon remains buried and preserved within these sediment layers for hundreds to thousands of years.

16. (D) Working Group II
The Intergovernmental Panel on Climate Change is structured into distinct working groups to systematically evaluate scientific information. Working Group II specifically focuses on assessing the vulnerability of socio-economic and natural systems to climate change, the positive and negative consequences of these impacts, and options for adapting to a warming global environment.

17. (C) Kyoto Protocol
The Clean Development Mechanism was established under the Kyoto Protocol as a flexible, market-based instrument. It allowed industrialized countries with binding emission reduction commitments to invest in emission-reduction projects in developing nations. These projects generated certified emission reduction credits, which developed countries could use to meet a portion of their emissions targets.

18. (B) Downscaling
Global Circulation Models operate at coarse spatial resolutions that are often inadequate for assessing localized environmental impacts. Downscaling is a critical methodological technique used to translate these large-scale atmospheric and oceanic projections into much higher-resolution regional models, enabling scientists to make precise predictions regarding local climate trends and coastal fisheries dynamics.

19. (D) Food web mass-balance
Ecopath with Ecosim is a widely utilized ecological modeling suite designed to analyze aquatic ecosystems. It provides a mass-balance framework that represents the trophic interactions

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58. (D) Reactive Oxygen Species (ROS) accumulation
Elevated sea surface temperatures disrupt the delicate symbiotic relationship between corals and their algal symbionts. Under thermal stress, the photosynthetic machinery of Symbiodiniaceae is damaged, leading to the excessive cellular accumulation of highly toxic reactive oxygen species. This oxidative stress damages host tissues, triggering the physiological expulsion of the algae from coral cells.

59. (A) Active metabolic rate and resting metabolic rate
Metabolic scope represents the energy budget available to an organism for performing activities beyond basic survival. In fish, it is calculated as the difference between the active metabolic rate and the resting or standard metabolic rate. As temperatures rise, resting metabolic costs increase, narrowing this scope and restricting energy for growth and reproduction.

60. (A) P-III, Q-I, R-IV, S-II
Climate oscillations display distinct geographic spheres of influence across the globe. The El Niño-Southern Oscillation centers over the equatorial Pacific. The Indian Ocean Dipole operates in the tropical Indian Ocean. The Pacific Decadal Oscillation influences the North Pacific, while the North Atlantic Oscillation governs atmospheric and oceanic patterns across the North Atlantic Ocean.

61. (B) Poleward expansion of tropical species
Tropicalization describes the ecological reorganization of temperate marine communities in response to ocean warming. As seawater temperatures increase, tropical species expand their geographical ranges poleward, invading temperate habitats. This influx of warm-water species, combined with the retreat of native cold-water species, alters trophic structures and grazing pressure in temperate kelp forests and rocky reefs.

62. (A) Sea-level rise and altered river discharge
Estuaries are dynamic transition zones highly vulnerable to climate change because they are simultaneously impacted by marine and terrestrial drivers. Rising sea levels push saltwater upstream, while altered regional precipitation patterns change the timing and volume of river discharge. These concurrent changes disrupt the salinity gradients, sediment dynamics, and nursery habitats critical for estuarine species.

63. (C) Life Cycle Assessment (LCA)
Life Cycle Assessment is a standardized, comprehensive methodology used to quantify the environmental impacts of a product across its entire lifespan. In fisheries, this framework evaluates energy use, greenhouse gas emissions, and resource depletion from the extraction of raw materials during vessel operations, through processing and transportation, to final consumer consumption and waste disposal.

64. (D) Elevating pH via carbon uptake
Seagrass meadows serve as vital coastal blue carbon ecosystems that can locally mitigate the impacts of ocean acidification. Through intensive daytime photosynthesis, seagrasses absorb dissolved carbon dioxide directly from the surrounding water column. This biological uptake of carbon reduces the concentration of carbonic acid, thereby elevating local seawater pH and buffering nearby calcifying organisms.

65. (C) Special Report on Emissions Scenarios
The Shared Socioeconomic Pathways represent the latest generation of climate scenarios utilized in the IPCC Sixth Assessment Report. They were developed to replace the outdated Special Report on Emissions Scenarios framework. SSPs combine projections of global socioeconomic development with greenhouse gas concentration trajectories to provide more integrated and realistic climate impact assessments.

66. (C) 2.0 °C
The Paris Agreement is a legally binding international treaty on climate change adopted in 2015. Its central goal is to limit global warming to well below two degrees Celsius, preferably to one point five degrees Celsius, compared to pre-industrial levels. Achieving this target requires rapid and deep reductions in global greenhouse gas emissions.

67. (D) Statistical downscaling
Statistical downscaling is a modeling methodology used to project local climate conditions from coarse global models. This approach establishes empirical mathematical relationships between large-scale atmospheric predictors and local historical weather observations. By applying these statistical functions to future global

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29. (B) Stronger than normal
During the La Niña phase of the El Niño-Southern Oscillation, the atmospheric pressure gradient across the equatorial Pacific Ocean intensifies. This meteorological shift strengthens the easterly trade winds beyond their typical baseline, which enhances the westward transport of warm surface waters. This process intensifies upwelling of cold, nutrient-rich deep waters in the eastern Pacific.

30. (D) I only
The Pacific Decadal Oscillation is a long-term climatic pattern centered over the North Pacific Ocean, operating on multi-decadal timescales of twenty to thirty years. Its warm phase is characterized by cooler sea surface temperatures in the central North Pacific and warmer temperatures along the North American coast, which actually suppresses rather than enhances coastal upwelling.

31. (C) Carbonate ions
Ocean acidification occurs as seawater absorbs anthropogenic carbon dioxide, producing excess hydrogen ions that lower the pH. These hydrogen ions chemically react with dissolved carbonate ions to form bicarbonate ions. This chemical buffering process significantly reduces the concentration of free carbonate ions, directly threatening marine calcifying organisms that require carbonate to construct their structures.

32. (D) It universally enhances the calcification rates of all crustacean species.
Ocean acidification imposes severe physiological challenges on marine life, including elevated energetic costs for calcification, reduced low-frequency acoustic absorption, and disrupted larval fish sensory systems. Although some crustaceans exhibit resilience due to unique shell chemistry and active ion regulation, acidification does not universally enhance calcification across all crustacean species, making this generalized statement incorrect.

33. (C) Coral bleaching
Coral bleaching is a stress response triggered by elevated sea surface temperatures and high solar irradiance. This environmental stress damages the photosynthetic apparatus of the symbiotic algae, Symbiodiniaceae, living within coral tissues. The host coral subsequently expels these damaged symbionts, exposing its white calcium carbonate skeleton and depriving the organism of its primary energy source.

34. (B) Oxygen supply cardiorespiratory capacity
The oxygen- and capacity-limited thermal tolerance hypothesis posits that a fish's thermal limits are primarily set by cardiorespiratory system capacity. As temperature rises, metabolic demand increases rapidly, but the ability of the heart and gills to deliver oxygen to tissues cannot keep pace. This creates a critical mismatch, limiting aerobic scope and determining thermal tolerance.

35. (D) Timing of recurring biological events
Phenological shifts refer to changes in the seasonal timing of recurring biological life cycle events in response to climatic variations. In aquatic ecosystems, warming temperatures alter the timing of critical ecological processes such as phytoplankton spring blooms, fish spawning migrations, and larval hatching, often leading to trophic mismatches between predators and their prey.

36. (A) Atlantic cod
The Atlantic cod is a cold-water marine fish species whose physiological performance is highly sensitive to temperature changes. In response to warming ocean waters in the North Atlantic, populations of this species have exhibited significant poleward range shifts. They actively migrate northward to track their preferred cooler thermal habitats and maintain optimal metabolic functioning.

37. (C) Have no space for species to migrate upward
High-altitude cold-water aquatic habitats are exceptionally vulnerable to global warming due to physical geographic constraints. As lower elevations warm, aquatic species attempt to migrate upward to maintain their thermal niches. However, species residing at mountain summits or high-altitude lakes face an absolute physical barrier with no remaining upward space, leading to localized extinctions.

38. (A) Purse seines for small pelagics
Seafood products exhibit highly variable carbon footprints depending on the harvesting gear used. Harvesting schooling small pelagic species using purse seines is an exceptionally efficient fishing method. Because these fish form dense schools near the surface, searching and catching

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by air-sea gas exchange. This process is driven by the gradient in the partial pressure of carbon dioxide across the air-water interface. This continuous exchange allows the ocean to absorb substantial amounts of anthropogenic emissions directly from the atmosphere.

78. (A) Eustatic sea-level rise
Eustatic sea-level rise refers to global changes in sea level driven by alterations in the total mass of water in the oceans. The melting of grounded ice sheets and glaciers adds freshwater directly to the marine environment, increasing ocean volume. This mass-driven change is distinct from steric effects, which represent volume changes from thermal expansion.

79. (C) Atlantic Meridional Overturning Circulation
In the high latitudes of the North Atlantic, surface waters transfer heat to the cold atmosphere, becoming extremely cold, saline, and dense. This dense water sinks to the ocean depths and flows southward, serving as the primary engine driving the Atlantic Meridional Overturning Circulation. This deep ocean conveyor system regulates northern hemisphere climate patterns.

80. (D) It strengthens significantly during El Niño events.
The Walker Circulation is a major zonal atmospheric cell spanning the equatorial Pacific Ocean. Normal conditions feature strong trade winds driven by pressure differences. During El Niño, the sea surface temperature gradient across the Pacific flattens, which dramatically weakens and disrupts this circulation cell, rather than strengthening it, making the assertion incorrect.

81. (C) Nitrate and phosphate nutrients
Suppressing coastal upwelling during El Niño events prevents cold, deep ocean waters from reaching the surface photic zone. This upwelling process is essential because deep waters are rich in macronutrients such as nitrates and phosphates. Depriving the surface layer of these essential nutrients collapses the phytoplankton populations, disrupting the entire marine food web.

82. (B) Activity of hydrogen ions
Ocean pH is a logarithmic scale used to quantify the acidity or alkalinity of seawater. It is determined by directly measuring the chemical activity of free hydrogen ions in the water. As the ocean absorbs carbon dioxide, the concentration of hydrogen ions increases, which causes a corresponding decrease in pH, indicating more acidic conditions.

83. (D) Calcite is less soluble in seawater than aragonite.
Calcium carbonate exists in marine environments primarily as two distinct mineral polymorphs: calcite and aragonite. Aragonite has an orthomorphic crystal structure that is thermodynamically less stable and more soluble in seawater than the trigonal structure of calcite. Consequently, calcite saturation states remain higher, and calcite structures are more resistant to dissolution under ocean acidification.

84. (A) High solar irradiance
Coral bleaching is a complex physiological response driven by multiple environmental factors. While elevated sea surface temperature is the primary trigger, high solar irradiance significantly exacerbates the bleaching process. Excessive light energy damages the photosynthetic apparatus of symbiotic zooxanthellae, accelerating the cellular production of toxic reactive oxygen species that lead to symbiont expulsion.

85. (C) Decline in cardiorespiratory capacity
In fish thermal physiology, pejus temperatures represent critical transition points within the thermal tolerance window. At these temperatures, the organism's cardiorespiratory capacity begins to decline, meaning its aerobic scope is no longer maximized. This physiological limitation reduces the energy available for ecological activities such as growth, swimming performance, and reproductive development.

86. (A) Photoperiod
Many aquatic species rely on environmental cues to synchronize the timing of critical life-history events, such as spawning migrations. Photoperiod, representing the seasonal change in daily light duration, is a highly reliable cue that remains entirely unaffected by climate change. This stability can cause phenological mismatches when temperature-dependent cues shift while light-dependent cues do not.

87. (B) P-III, Q-I, R-IV, S-II
Global Circulation Models simulate complex global climate systems. Species Distribution Models are utilized for predicting habitat

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shifts of species under environmental change. Ecopath with Ecosim is designed for modeling aquatic food webs and trophic interactions. Life Cycle Assessment serves as a standardized method for assessing supply chain emissions and environmental footprints, matching each tool to its function.

88. (B) Inability to migrate to colder habitats
Boreal and polar marine species are highly adapted to extremely cold, stable thermal environments. As oceans warm, these species face severe extinction risks because they have narrow thermal tolerances. Unlike temperate species that can migrate poleward to escape warming, polar species reside at the physical limits of the planet, leaving them with no colder marine habitats.

89. (C) Halophytic vegetation
Salt marshes function as highly effective coastal blue carbon sinks. Their carbon sequestration capacity is heavily dependent on the presence of halophytic vegetation, which consists of salt-tolerant plants. These plants trap sediment, produce substantial organic biomass, and shade the soil surface. This vegetation maintains the waterlogged, anaerobic conditions that inhibit decomposition, facilitating long-term carbon burial.

90. (D) Kite rigs on trawls - Increases fuel consumption
Carbon footprint mitigation in fisheries utilizes various technological innovations to improve energy efficiency. Hull cleaning reduces hydrodynamic drag, speed reduction exponentially decreases fuel use, and solar panels reduce auxiliary diesel consumption. Using kite rigs on trawlers is designed to harness wind energy to assist propulsion, which decreases rather than increases fuel consumption, making this pair incorrect.

91. (A) Coastal vegetated ecosystems
The term blue carbon was introduced into international environmental policy to emphasize the global significance of coastal vegetated ecosystems in carbon sequestration. While oceans cover most of the planet, vegetated coastal habitats such as mangroves, salt marshes, and seagrass meadows store disproportionately vast amounts of organic carbon within their soils, serving as critical natural carbon sinks.

92. (B) Radiative forcing values in 2100
Representative Concentration Pathways are greenhouse gas concentration trajectories used by the Intergovernmental Panel on Climate Change. These pathways are defined and named based on their projected target radiative forcing values, measured in watts per square meter, by the year twenty-one hundred. They provide standardized inputs for climate models to project future global warming.

93. (B) Market-based cost-effective reductions
Carbon trading mechanisms are market-based policy instruments designed to reduce global greenhouse gas emissions. By establishing a cap on emissions and allowing entities to buy and sell carbon credits, these systems assign a financial value to carbon. This economic incentive encourages industries to achieve cost-effective emission reductions, promoting investments in low-carbon technologies across various sectors.

94. (A) Stationarity of statistical relationships
Statistical downscaling is a method used to derive local climate projections from coarse global models. This technique is fundamentally based on the assumption of stationarity, meaning that the empirical statistical relationships established between large-scale atmospheric variables and local historical weather patterns will remain constant and valid under future changed climate conditions.

95. (C) Hutchinson's niche principles
Species Distribution Modeling is a scientific framework used to predict habitat suitability based on environmental conditions. This approach is conceptually rooted in Hutchinson's niche principles, which distinguish between the fundamental niche, representing the physiological tolerances of a species, and the realized niche, which accounts for biotic interactions and determines actual geographical occurrence patterns.

96. (B) I, III and IV
Standard climate vulnerability assessment frameworks systematically evaluate three core interacting components: exposure, representing the degree to which a system experiences climate stressors; sensitivity, indicating its susceptibility to these changes; and adaptive capacity, which reflects its ability to adjust and cope. Economic

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profitability is an operational metric rather than a core vulnerability framework component.

97. (C) Return path requires different conditions
Hysteresis is a critical phenomenon in ecological resilience that describes a lagged or non-reversible response of an ecosystem to environmental stress. It indicates that once an ecosystem undergoes a phase shift to a degraded state, simply restoring the original environmental conditions is insufficient for recovery; a much larger reduction in stress is required to trigger restoration.

98. (B) Alternative propulsion fuel transition
Decarbonization of a commercial fishing fleet refers to the systemic reduction of greenhouse gas emissions associated with maritime operations. This process most directly involves transitioning from conventional diesel engines to alternative propulsion systems, such as hybrid electric motors, hydrogen fuel cells, or biofuels, thereby reducing fossil carbon emissions during active harvesting activities.

99. (D) Shifting fish phenology and spawning
Modifying fishing seasons is a critical climate adaptation strategy in fisheries management. As ocean warming shifts the seasonal timing of fish spawning, migration, and growth, static calendar-based management becomes ineffective. Adjusting fishing seasons in response to these altered biological timings protects vulnerable life stages, prevents recruitment failure, and aligns harvesting activities with changing resource availability.

100. (A) Both A and R are true and R is the correct explanation of A.
Coastal fisheries face severe risks from climate-induced extreme weather, making disaster risk reduction essential. Implementing mangrove afforestation is a highly effective ecosystem-based strategy, as these coastal forests form a dense physical barrier of roots and trunks. This vegetation attenuates wave energy, reduces storm surges, and prevents shoreline erosion, protecting both marine habitats and human coastal communities.

101. (C) Chlorofluorocarbons (CFCs)
While greenhouse gases like carbon dioxide, methane, and nitrous oxide occur naturally and are cycled through the biosphere, chlorofluorocarbons are entirely synthetic. These chlorine-bearing chemical compounds were developed in the twentieth century for industrial applications, refrigeration, and propellants. They are exclusively of anthropogenic origin, possessing exceptionally high global warming potentials and ozone-depleting capacities.

102. (B) Microbes convert labile dissolved organic carbon into recalcitrant forms
The microbial carbon pump is a biological process in marine ecosystems where heterotrophic bacterioplankton process dissolved organic matter. These microbes chemically alter easily degradable, labile dissolved organic carbon into highly complex, recalcitrant forms. This recalcitrant carbon is highly resistant to microbial decomposition, allowing it to remain dissolved and sequestered in the deep ocean for centuries.

103. (D) Saltwater intrusion into freshwater ponds
Sea-level rise poses direct threats to coastal aquaculture infrastructure, particularly freshwater aquaculture systems. As sea levels rise, saltwater penetrates inland, causing high-salinity water to intrude into freshwater coastal ponds and aquifers. This sudden salinization alters water chemistry, exceeds the osmotic tolerance limits of freshwater cultured species, and severely disrupts regional aquaculture production.

104. (B) The Coriolis parameter
Large-scale surface ocean currents are significantly deflected from their wind-driven path due to the rotation of the Earth. This physical deflection is mathematically described by the Coriolis parameter, which varies with latitude. The Coriolis effect forces moving water to the right in the Northern Hemisphere and to the left in the Southern Hemisphere, shaping global circulation.

105. (B) III only
Transitions between different phases of the El Niño-Southern Oscillation are driven by complex ocean-atmosphere coupling. Subsurface ocean temperature anomalies and thermocline depth adjustments propagate across the equatorial Pacific basin as large-scale, slow-moving planetary waves. These ocean dynamics are mediated specifically by equatorial Kelvin waves traveling eastward and Rossby waves propagating westward.

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125. (A) Both A and R are true and R is the correct explanation of A.
The physical solubility of carbon dioxide in ocean waters is highly sensitive to temperature changes. As seawater warms, the kinetic energy of the water molecules increases, which reduces the stability of dissolved gas molecules and drives them out of solution. Consequently, warmer oceans absorb less carbon dioxide, making both statements true and logically linked.

126. (A) Global Warming Potential
Global Warming Potential is a standardized metric used to compare the climate impacts of different greenhouse gases. This index integrates both the radiative efficiency, representing the gas's ability to absorb infrared radiation, and its atmospheric lifetime, reflecting how long it remains in the atmosphere, relative to the reference gas, carbon dioxide.

127. (C) Steric sea-level rise
Sea-level rise is driven by two primary physical processes: mass additions from melting land ice and volume changes from warming. Steric sea-level rise refers specifically to the density-driven volume expansion of seawater. As the oceans absorb excess heat from the atmosphere, the water expands thermally, driving global sea levels upward.

128. (D) Nutrient limitation (e.g., iron, nitrogen)
The biological carbon pump relies on marine primary producers to fix dissolved inorganic carbon in the surface ocean. In vast oligotrophic regions, also known as marine deserts, this biological activity is severely restricted by nutrient limitation. Deprived of essential macronutrients like nitrogen or micronutrients like iron, phytoplankton cannot flourish, limiting carbon export to the deep ocean.

129. (C) Cold and saline
Thermohaline circulation is driven by density variations in seawater, which are controlled by temperature and salinity. Cold water is physically denser than warm water because its molecules are less active and tightly packed, while high salinity increases density by adding dissolved salts. Therefore, seawater is dense when it is cold and highly saline.

130. (A) I, II and IV
The El Niño-Southern Oscillation is a major interannual climate pattern. El Niño represents warm sea surface temperature anomalies in the eastern equatorial Pacific, while La Niña represents cold anomalies. The Southern Oscillation Index tracks atmospheric pressure changes across this basin. Because ENSO events typically persist for nine to twelve months rather than years, statement III is incorrect.

131. (D) Western and Eastern equatorial Indian Ocean
The Indian Ocean Dipole is a coupled ocean-atmosphere climate mode that operates in the equatorial Indian Ocean. It is defined by sea surface temperature anomalies and associated wind shifts. The IOD is characterized specifically by the temperature gradient between the western equatorial Indian Ocean, off East Africa, and the southeastern equatorial Indian Ocean, off Indonesia.

132. (A) $CO_3^{\{2-\}}$
Dissolving anthropogenic carbon dioxide in seawater generates excess hydrogen ions, driving ocean acidification. These hydrogen ions chemically react with dissolved carbonate ions to buffer the change, forming bicarbonate. This chemical reaction significantly reduces the concentration of biologically critical carbonate ions, directly impairing shell-building marine species that require carbonate to construct calcium carbonate structures.

133. (C) Aragonite
Coral reefs are highly vulnerable to ocean acidification because their massive three-dimensional structures are composed of aragonite, a soluble crystalline polymorph of calcium carbonate. As acidification reduces the ocean's aragonite saturation state, corals must expend more energy to calcify, leading to weakened skeletal structures, slower reef growth, and accelerated structural dissolution.

134. (A) Production of toxic reactive oxygen species (ROS) in symbionts due to heat
Under elevated seawater temperatures and high solar irradiance, the photosynthetic pathways within Symbiodiniaceae are severely damaged. This disruption leads to the excessive cellular accumulation of highly toxic reactive oxygen species. To protect itself from this oxidative

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carbon sink across higher-latitude estuaries and shorelines.

116. (A) United Nations Environment Programme (UNEP)
The Intergovernmental Panel on Climate Change is a prominent international scientific body established in 1988. It was jointly created under the auspices of the World Meteorological Organization and the United Nations Environment Programme. The IPCC synthesizes global peer-reviewed scientific literature to provide policymakers with comprehensive assessments of climate change and adaptation strategies.

117. (C) Annex I (developed) countries
The Kyoto Protocol, adopted in 1997, was a milestone international treaty designed to reduce greenhouse gas emissions. A defining feature of this agreement was the establishment of legally binding emission reduction targets exclusively for Annex I countries, which comprised developed nations. This structure was based on the principle of common but differentiated responsibilities.

118. (A) A mathematical representation of planetary atmospheric and oceanic processes
A Global Circulation Model is a complex, physics-based computer simulation designed to project global climate patterns. These models solve fundamental mathematical equations governing atmospheric dynamics, ocean circulation, heat transfer, and radiation balance. GCMs serve as the primary scientific tools for simulating how greenhouse gas emissions alter long-term global temperature and precipitation regimes.

119. (D) Fluid dynamics and biogeochemical tracers simultaneously
Coupled physical-biological models are essential for understanding how climate change impacts marine ecosystems. These integrated models solve complex equations governing physical fluid dynamics, such as currents and mixing, while simultaneously tracking biogeochemical tracers like nutrients and phytoplankton. This approach allows scientists to simulate how physical oceanographic changes alter biological productivity and marine habitats.

120. (B) I and III
A fishery's sensitivity to climate change is determined by its ecological and operational characteristics. High reliance on a single target species increases vulnerability, as there are no alternative target options if that population declines. Similarly, target species with narrow thermal tolerances are highly susceptible to warming, directly elevating the sensitivity of the entire fishery.

121. (C) Small environmental changes cause rapid and disproportionate ecological responses
Ecological thresholds represent critical boundaries in ecosystem dynamics. When an environmental stressor, such as ocean temperature or nutrient pollution, increases past this threshold, the ecosystem responds non-linearly. A minor additional increase in stress triggers a rapid, disproportionate, and often irreversible shift in ecosystem structure, potentially causing a regime shift to a degraded state.

122. (D) Climate change mitigation
Implementing economic policies such as fuel taxes or carbon pricing within the fisheries sector is designed to internalize the environmental costs of fossil fuel combustion. By increasing the cost of carbon-intensive operations, these policies incentivize vessel owners to adopt energy-efficient technologies, reduce speed, and transition to alternative propulsion systems, driving climate change mitigation.

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123. (A) Sea-level rise and saltwater intrusion
Coastal aquaculture systems are highly vulnerable to rising sea levels, which drive saltwater intrusion into freshwater estuaries and coastal ponds. Developing saline-tolerant species through selective breeding or genetic selection represents a targeted adaptation strategy. This allows aquaculture operations to maintain food production and economic viability despite increasing salinity in formerly freshwater zones.

124. (C) Eight
India launched its comprehensive National Action Plan on Climate Change in 2008 to address global warming challenges. The NAPCC was designed around eight core national missions representing multi-sectoral strategies. These original missions focus on solar energy, enhanced energy efficiency, sustainable habitat, water conservation, sustaining the Himalayan ecosystem, green India, sustainable agriculture, and strategic knowledge.

development and technology transfer while offering cost-effective mitigation.

144. (D) Using high-resolution Regional Climate Models (RCMs) driven by GCM boundary conditions
Dynamical downscaling is a computationally intensive modeling technique used to obtain highly localized climate projections. This approach involves running high-resolution Regional Climate Models over a specific area. These regional models are nested within and driven by the large-scale boundary conditions simulated by coarse Global Circulation Models, capturing fine-scale atmospheric and topographic features.

145. (C) Foraging capacities and primary production rates
The Ecopath with Ecosim modeling suite allows researchers to simulate climate change impacts on marine food webs. It incorporates climate forcing functions by linking environmental variables, such as sea surface temperature or salinity, directly to biological parameters. These variables modify the foraging capacity of consumers and primary production rates, driving trophic changes.

146. (B) Risk Assessment Matrix
Fisheries vulnerability assessments often utilize a standardized Risk Assessment Matrix to evaluate climate hazards. This methodology scores the likelihood of a specific climate threat, such as a marine heatwave, against the ecological or socio-economic consequences of that event. This qualitative or semi-quantitative approach helps managers prioritize adaptation actions for vulnerable fisheries.

147. (D) Fleshy macroalgae
A phase shift on a coral reef represents a persistent transition from a species-rich ecosystem dominated by reef-building corals to an alternative stable state. This ecological degradation is typically characterized by the dominance of fleshy macroalgae. This transition is driven by cumulative stressors such as mass bleaching, nutrient pollution, and the overfishing of herbivorous fish.

148. (A) Shifting transport from air freight to maritime shipping
Post-harvest operations contribute significantly to the carbon footprint of the seafood supply chain. Shifting the distribution of fishery products from high-emission air freight to energy-efficient maritime shipping dramatically reduces fuel consumption per ton-kilometer. This transportation shift serves as a highly effective mitigation strategy for lowering the overall greenhouse gas emissions of seafood.

149. (C) Adaptive management and dynamic seasonal closures
Climate-smart fisheries management advocates for flexible governance structures to cope with shifting marine resources. Because climate change drives unpredictable range shifts and altered spawning timings, static regulations are ineffective. Implementing adaptive management and dynamic seasonal closures allows managers to adjust fishing activities in real-time, protecting fluctuating fish populations and securing coastal livelihoods.

150. (A) Both A and R are true and R is the correct explanation of A.
Adopting circular economy principles within the fisheries sector is an effective climate mitigation strategy, making the assertion correct. Circular practices focus on minimizing waste by processing and valorizing fish by-products into high-value feeds or oils. This reduces the resource demand for raw material extraction, lowering the overall carbon footprint of seafood production.

151. (D) Methane
Methane is a potent greenhouse gas produced biologically in aquatic systems through methanogenesis. In stagnant wetlands, waterlogged soils, and oxygen-depleted sediments, anaerobic archaea decompose organic matter in the complete absence of oxygen. This metabolic process generates substantial biogenic methane emissions, which are subsequently released from the water column into the atmosphere.

152. (B) It is driven entirely by the physical cooling of surface waters.
The biological pump is an organic carbon export mechanism driven by marine organisms rather than physical cooling alone, making this statement incorrect. It begins with photosynthetic carbon fixation by phytoplankton in the photic zone.

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stress, the host coral polyp is forced to expel these damaged zooxanthellae, resulting in coral bleaching.

135. (D) Decreases
The concentration of dissolved oxygen in aquatic ecosystems is governed by physical laws of solubility. As water temperatures rise, the kinetic energy of water molecules increases, which reduces the solubility of dissolved gases. Consequently, the oxygen saturation point decreases in warmer waters, exacerbating the risks of hypoxia for marine and freshwater organisms.

136. (B) Fish larvae and their zooplankton prey
The match-mismatch hypothesis is an ecological concept explaining recruitment variability in fisheries. It highlights the critical temporal and spatial overlap required between newly hatched fish larvae and their primary food source, zooplankton. If climate change shifts the seasonal timing of these groups unequally, a mismatch occurs, causing larval starvation and recruitment failure.

137. (C) Increased competition and predation from range-expanding tropical species
Tropicalization alters temperate marine ecosystems as warming temperatures allow tropical species to expand their ranges poleward. Native temperate species are highly vulnerable to this influx, as range-expanding tropical herbivores and predators can outcompete them for resources or directly consume them, leading to the collapse of temperate kelp forests and associated communities.

138. (D) Rapid glacial retreat altering hydrological regimes
High-altitude aquatic ecosystems face unique climate vulnerabilities due to their dependence on cryospheric water sources. Rising global temperatures drive rapid glacial retreat and reduced snowpack accumulation, which fundamentally alters local hydrological regimes. This causes severe changes in seasonal river discharge, increased water temperatures, and altered sedimentation, threatening cold-water fish populations.

139. (A) Indirect emissions (Scope 2 or 3)
In fisheries carbon footprint assessments, emissions are categorized into different scopes. Direct diesel combustion by the vessel engine represents Scope one. In contrast, the electricity consumed during land-based ice production and the manufacturing of onboard refrigerants are classified as indirect emissions, falling under Scope two or Scope three within the product value chain.

140. (A) P-III, Q-II, R-IV, S-I
The United Nations Framework Convention on Climate Change provides the overall framework for global climate negotiations. The Kyoto Protocol set legally binding emissions targets for developed countries. The Paris Agreement introduced Nationally Determined Contributions targeting a one point five degree limit. The Intergovernmental Panel on Climate Change is responsible for scientific climate assessments, mapping each entity.

141. (B) The anoxic nature of mangrove sediments prevents rapid carbon remineralization
Mangroves are highly efficient coastal blue carbon sinks because they trap organic matter in waterlogged soils. The lack of oxygen in these anaerobic sediments severely restricts the activity of aerobic decomposers, preventing the microbial breakdown and remineralization of organic carbon. Consequently, carbon remains locked and sequestered in these soils for centuries or millennia.

142. (A) Radiative forcing driven by greenhouse gas concentrations
Representative Concentration Pathways are standardized future scenarios used in climate modeling. These pathways represent alternative trajectories of radiative forcing, measured in watts per square meter, which is driven by atmospheric greenhouse gas concentrations. They allow scientists to model how different global emissions mitigation scenarios will impact global temperatures and sea levels.

143. (C) Investing in emission-reduction projects in developing countries
The Clean Development Mechanism was a flexible policy instrument established under the Kyoto Protocol. It allowed developed nations with binding emission targets to meet a portion of their commitments by investing in greenhouse gas reduction projects in developing countries. This mechanism encouraged sustainable

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181. (C) Low pH and low dissolved oxygen
Coastal upwelling zones are highly productive marine regions driven by winds that bring deep ocean waters to the surface. However, these deep waters are naturally cold, enriched in carbon dioxide, and depleted of oxygen. Consequently, upwelling zones are naturally prone to low pH and low dissolved oxygen, stressors that are further intensified by climate change.

182. (C) $\Omega < 1$
The saturation state, represented by omega, determines the thermodynamic propensity for calcium carbonate to dissolve or precipitate in seawater. When omega is greater than one, seawater is supersaturated, favoring shell construction. When omega falls below one, seawater becomes undersaturated and corrosive, initiating the active chemical dissolution of carbonate shells and skeletons.

183. (D) Echinoderms
Echinoderms, such as sea urchins, starfish, and sea cucumbers, are highly vulnerable to ocean acidification. Their complex internal skeletons and protective spines are composed of high-magnesium calcite. This mineral form of calcium carbonate is thermodynamically unstable and highly soluble compared to low-magnesium calcite, making echinoderm structures exceptionally susceptible to dissolution as pH declines.

184. (B) Chloroplast (specifically photosystem II)
Coral bleaching is initiated at the cellular level within the algal symbionts. Elevated sea surface temperatures, coupled with high solar irradiance, damage the light-harvesting apparatus inside the Symbiodiniaceae chloroplasts. This disruption specifically targets photosystem II, halting normal photosynthesis and triggering the excessive production of toxic reactive oxygen species that lead to symbiont expulsion.

185. (C) Aerobic scope begins to decline, indicating things are "getting worse"
In fish thermal physiology, the pejus temperature represents a critical physiological turning point. At this temperature, the animal's cardiorespiratory capacity can no longer support its maximum oxygen demand under warming. Consequently, its aerobic scope begins to decline, indicating that physiological conditions are getting worse, which limits energy for growth, performance, and reproduction.

186. (A) P-IV, Q-III, R-I, S-II
Climate change impacts marine systems through distinct environmental drivers. Ocean warming directly forces biogeographical range shifts of species. Phenological changes alter biological timing, resulting in mismatched spawning cues. Ocean acidification drives carbonate shell dissolution in calcifying organisms. Sea-level rise floods low-lying coastal areas, causing nursery habitat inundation, systematically matching each impact to its driver.

187. (A) Subjecting them to increased herbivory by range-expanding tropical fish
Tropicalization alters temperate marine ecosystems as warming seawater temperatures allow tropical species to expand poleward. In temperate kelp forests, this range expansion introduces herbivorous tropical fish. These warm-water grazers subject native macroalgae to intense herbivore pressure, overgrazing the canopy and driving the collapse of kelp forests into barren, degraded habitats.

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188. (B) Sea-level rise pushes habitats landward against fixed anthropogenic infrastructure
Coastal squeeze is a major vulnerability facing intertidal estuarine habitats. As sea-level rise pushes coastal ecosystems landward, these habitats would naturally migrate inland. However, when the landward margin is blocked by hard anthropogenic infrastructure, such as seawalls, roads, or urban development, the intertidal zone is trapped, compressed, and eventually lost.

189. (B) Natural predation rates of the target species
Life Cycle Assessment is a standardized tool designed to quantify the environmental footprints associated with human industrial activities and supply chains. It evaluates fossil fuel consumption during fishing, refrigerants used onboard, and electricity used during processing. It does not include natural ecological processes, such as natural predation rates, as they are not anthropogenic resource inputs.

190. (A) The project sequesters more carbon than would have occurred in its absence
Additionality is a fundamental requirement for blue carbon offset projects to receive verified

This organic matter is subsequently transported to the deep ocean as sinking marine snow, effectively sequestering atmospheric carbon dioxide.

153. (C) Upstream saltwater intrusion and habitat inundation
Sea-level rise poses severe threats to estuarine ecosystems by shifting the marine-freshwater boundary. It drives saltwater intrusion far upstream, altering the delicate salinity gradients that structure estuarine communities. Additionally, rising water levels inundate critical intertidal mudflats and salt marshes, squeezing these essential nursery habitats against coastal development and reducing fisheries productivity.

154. (D) Global wind patterns transferring momentum to the sea surface
Surface ocean currents are primarily generated by global atmospheric circulation. As major wind belts, such as the trade winds and westerlies, blow across the ocean, they transfer kinetic energy and momentum to the water surface through frictional drag. This wind-driven force, modified by the Earth's rotation, generates large-scale horizontal surface currents.

155. (A) Shallower than normal
During a strong La Niña event, the atmospheric Walker Circulation intensifies, strengthening the easterly trade winds. These winds pile up warm surface waters in the western Pacific, while exposing cold subsurface waters in the east. Consequently, the oceanic thermocline in the eastern equatorial Pacific becomes significantly shallower than its normal climatological depth.

156. (A) I, III, II, IV
Modeling the biological impacts of ocean acidification requires a systematic sequence of steps. First, future atmospheric carbon dioxide emissions are projected. Next, air-sea gas exchange rates are estimated to determine ocean absorption. This allows scientists to calculate subsequent chemical changes in seawater pH and saturation state, culminating in assessing biological impacts on calcifiers.

157. (B) Pre-industrial ocean pH - Approximately 8.2
Seawater pH has changed significantly since the industrial revolution due to carbon dioxide absorption. The pre-industrial average sea surface pH was approximately eight point two. Since then, the absorption of anthropogenic emissions has reduced global surface ocean pH to approximately eight point one, representing a thirty percent increase in seawater acidity over historical baselines.

158. (A) Reduced somatic growth and reproductive output
Under ocean acidification, the saturation state of calcium carbonate decreases, making shell formation chemically challenging. Marine molluscs must expend significantly more metabolic energy to actively regulate ions and maintain calcification. This increased energy demand forces a physiological trade-off, leaving less energy available for somatic growth, tissue maintenance, and reproductive output.

159. (C) 12 weeks
Degree Heating Weeks is a cumulative thermal stress index used to predict coral bleaching risks. This metric integrates the duration and intensity of sea surface temperature anomalies. It is calculated by accumulating weekly temperature anomalies that exceed the bleaching threshold over a continuous, rolling twelve-week window, providing a reliable predictor of bleaching severity.

160. (B) II and IV
Fish are ectothermic organisms whose internal body temperature is dictated by their surrounding environment. As water temperatures rise, their resting metabolic rate increases, which elevates cellular oxygen demand. However, extreme temperatures past their critical limits lead to the denaturation of metabolic enzymes, causing cardiorespiratory failure and mortality, making statements II and IV correct.

161. (C) Larval fish survival and recruitment
Cushing's match-mismatch hypothesis is a foundational concept in fisheries oceanography. It is specifically applied to study larval fish survival and recruitment dynamics. The hypothesis posits that the survival of newly hatched larvae depends on the temporal overlap with seasonal plankton blooms, explaining how climate-driven shifts in bloom timing drive annual recruitment fluctuations.

162. (B) Warming surface temperatures
Many marine fish species exhibit vertical range shifts, migrating to deeper waters within the

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water column as climate change progresses. This behavioral response is primarily driven by the need to avoid warming surface temperatures. By retreating to deeper, cooler water layers, fish can maintain their optimal thermal niches and avoid metabolic stress.

163. (D) They consist of angiosperms adapted to coastal, saline environments.
Mangroves, salt marshes, and seagrasses are key coastal blue carbon ecosystems. They share the unique biological trait of consisting of vascular flowering plants, known as angiosperms, that have evolved specialized physiological adaptations to survive submerged in saline coastal waters. These traits allow them to construct extensive habitats that trap and sequester organic carbon.

164. (A) Marine diesel combustion during fishing operations
Life cycle assessments of pelagic longlining fisheries consistently show that fuel consumption is the primary driver of environmental impacts. Dragging gear and searching for target fish requires vessels to operate diesel engines continuously. Consequently, the direct combustion of marine diesel during active fishing operations generates the vast majority of greenhouse gas emissions within this fishery.

165. (C) It releases centuries of stored carbon back into the atmosphere or water column
Coastal blue carbon ecosystems sequester vast reservoirs of organic carbon within their anaerobic sediments. When these habitats are degraded or destroyed, the soil is exposed to oxygen, accelerating aerobic microbial decomposition. This rapid decay remineralizes the organic matter, releasing centuries of stored carbon back into the water column and atmosphere as greenhouse gases.

166. (A) The physical science basis of climate change
The Intergovernmental Panel on Climate Change is divided into three distinct working groups to synthesize scientific information. Working Group I is specifically tasked with assessing the physical science basis of the climate system and climate change. It evaluates observations and models of temperature, greenhouse gas concentrations, ocean warming, and sea-level rise.

167. (D) Prevent dangerous anthropogenic interference with the climate system
The primary objective of the United Nations Framework Convention on Climate Change is to stabilize global greenhouse gas concentrations. This international treaty seeks to prevent dangerous anthropogenic interference with the climate system. By establishing cooperative frameworks, it enables nations to negotiate binding emissions reduction targets and collaborate on global adaptation and mitigation strategies.

168. (B) Stationary climate relationships over time
Statistical downscaling is a computationally efficient method for deriving high-resolution local climate projections from global models. However, this approach is fundamentally dependent on the stationarity assumption. This assumes that the empirical statistical relationships established between large-scale atmospheric variables and local weather patterns will remain constant and valid under a changing future climate.

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169. (C) Maximum Entropy (MaxEnt)
Species Distribution Models are widely used to predict habitat suitability under climate change. When only species presence records are available, researchers commonly utilize the Maximum Entropy algorithm. MaxEnt estimates the target probability distribution of a species across a study area by finding the distribution of maximum entropy subject to constraints representing environmental spatial layers.

170. (D) Vulnerability = (Exposure + Sensitivity) - Adaptive Capacity
In IPCC climate frameworks, vulnerability represents the degree to which a system is susceptible to climate impacts. It is mathematically conceptualized as a function of three components. Vulnerability increases with exposure, representing external climate hazards, and sensitivity, reflecting internal fragility, but is reduced by adaptive capacity, which represents the system's ability to cope and recover.

171. (A) A critical threshold where a small change causes a rapid shift to a new ecosystem state
A tipping point is a critical threshold in ecological dynamics. When an ecosystem is subjected to cumulative pressures like warming and overfishing, it can approach this critical boundary. Once reached, a minor additional

disturbance triggers rapid, self-reinforcing, and often irreversible changes, shifting the ecosystem into an alternative, often degraded stable state.

172. (B) Traps and pots
Fishing gears are categorized as active or passive based on their operational mechanics. Traps and pots are passive gears that remain stationary on the seabed, relying on species behavior to enter the gear. Because they require vessel power only for deployment and recovery, they consume minimal fuel, exhibiting a lower carbon footprint than active trawls.

173. (D) Expanding single-species intensive farming in highly vulnerable coastal zones
Climate-smart aquaculture focuses on adapting operations to environmental changes while minimizing risks. Strategies include breeding for thermal tolerance and implementing integrated multi-trophic systems. However, expanding highly intensive single-species farming in vulnerable coastal zones increases susceptibility to disease, storms, and saline intrusion, which contradicts the core principles of climate-smart adaptation.

174. (A) Early warning systems for extreme weather events
The Food and Agriculture Organization emphasizes disaster risk reduction in fisheries to build community resilience. A key component of this framework is the implementation of early warning systems for extreme weather events. These communication networks provide fishers with timely forecasts, allowing them to secure their gear, avoid hazardous sea conditions, and protect coastal infrastructure.

175. (D) A is false but R is true.
Global Circulation Models are highly advanced physics-based simulations designed to project long-term climatic trends across large spatial scales, making the reasoning true. However, because GCMs operate at coarse spatial and temporal resolutions, they cannot provide exact, pinpoint weather forecasts for local fishing grounds decades in advance, rendering the initial assertion false.

176. (D) N_2O
Nitrous oxide is a highly potent greenhouse gas produced in marine ecosystems. In ocean oxygen minimum zones, low-oxygen conditions accelerate microbial nitrogen cycling. Under these hypoxic conditions, intermediate processes of nitrification and particularly denitrification convert dissolved nitrate into gaseous nitrous oxide, which is subsequently released into the water column and the atmosphere.

177. (C) Cold, oxygen-rich surface waters sink and spread across the ocean floor
Deep ocean ventilation is a fundamental physical process that links the surface ocean with the abyss. It occurs when cold, dense, and oxygen-rich surface waters at high latitudes sink to great depths during deep-water formation. This downwelling transports oxygen directly to the ocean interior, spreading across the seafloor and regulating benthic ecosystems.

178. (B) Altering or degrading critical nursery habitats like estuaries and mangroves
Sea-level rise impacts nearshore fisheries primarily by degrading critical coastal habitats. Rising water levels inundate and alter the salinity gradients of estuaries, salt marshes, and mangrove forests. Because these vegetated habitats serve as vital nurseries for juvenile fish and shellfish, their loss or degradation directly reduces recruitment and productivity of nearshore fishery resources.

179. (D) Subtropical oceanic gyres
Surface winds transfer momentum to the ocean, generating currents that are deflected by the Earth's rotation. This Coriolis effect deflects moving water to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. This deflection, combined with continental boundaries, drives the formation of massive, closed circular current systems called subtropical gyres.

180. (A) II, III and IV
The Indian Ocean Dipole is a coupled ocean-atmosphere climate mode in the Indian Ocean. Its positive phase is characterized by warmer sea surface temperatures in the western Indian Ocean and cooler temperatures in the east, which drives increased rainfall in East Africa. Because it influences the monsoon and operates independently of ENSO, statements II, III, and IV are correct.

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106. (D) North Pacific
The Pacific Decadal Oscillation is a long-term climate variability pattern centered over the North Pacific Ocean basin. Operating on multi-decadal cycles of twenty to thirty years, the PDO is characterized by widespread sea surface temperature and atmospheric pressure anomalies. It exerts a profound influence on marine food webs, salmon recruitment, and coastal fisheries productivity.

107. (A) Increased hydrogen ion concentration raises the ocean pH.
Ocean acidification chemistry is governed by the dissolution of carbon dioxide in seawater, which forms carbonic acid and subsequently releases hydrogen ions. However, pH is defined as the negative logarithm of hydrogen ion concentration. Therefore, an increase in hydrogen ions causes a decrease in ocean pH, making the assertion that it raises pH chemically incorrect.

108. (B) Aragonite
Pteropods are small, pelagic marine gastropods that are exceptionally vulnerable to ocean acidification. Their delicate shells are composed of aragonite, a crystalline polymorph of calcium carbonate that is highly soluble and unstable compared to calcite. As acidification reduces the aragonite saturation state, these organisms struggle to calcify, experiencing rapid shell dissolution and structural damage.

109. (B) 1.0 °C
Degree Heating Weeks is a cumulative thermal stress index used to monitor coral bleaching. This metric accumulates sea surface temperature anomalies over a rolling twelve-week window. Thermal stress is only added to the accumulation when regional temperatures exceed the historical maximum monthly mean climatology by at least one degree Celsius, representing a critical bleaching threshold.

110. (B) Mangroves, Salt marshes, Open ocean
Different marine ecosystems possess highly variable carbon sequestration capacities per unit area. Vegetated coastal habitats are exceptionally efficient carbon sinks. Mangroves typically exhibit the highest annual carbon burial rates per hectare, followed closely by salt marshes. In contrast, while the open ocean is vast, its sequestration rate per hectare is extremely low due to low nutrient density.

111. (C) Phenological mismatch
A phenological mismatch is an ecological disruption that occurs when interacting species shift the seasonal timing of their life cycles at different rates. In marine environments, warming can accelerate phytoplankton blooms while zooplankton or larval fish hatching remains unchanged. This temporal desynchronization deprives young fish of essential food, leading to starvation and recruitment failure.

112. (D) Isotherms
Marine ectotherms are highly sensitive to seawater temperatures, which dictate their metabolic rates. As ocean surface layers warm due to climate change, many species migrate to deeper water columns. This vertical migration allows fish to track their preferred thermal niches, effectively following specific isotherms to maintain physiological homeostasis and avoid lethal temperature stress.

113. (C) Increased light attenuation from deeper water
Seagrass meadows are benthic coastal plants that are highly dependent on solar irradiance for photosynthesis. Sea-level rise increases the depth of the water column overlying these meadows, which increases light attenuation. Deeper water reduces the amount of photosynthetically active radiation reaching the seabed, limiting seagrass growth, survival, and carbon sequestration capacity.

114. (B) Life Cycle Inventory (LCI)
Life Cycle Assessment is a standardized, multi-phase methodology used to evaluate environmental impacts. The phase that specifically quantifies all inputs, such as raw materials and energy, and outputs, including atmospheric emissions and waste products, across the system boundary is the Life Cycle Inventory. This database serves as the foundation for subsequent impact assessments.

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115. (D) Salt marshes - Temperate regions
Blue carbon ecosystems are vegetated coastal habitats that sequester carbon, and their distribution is heavily influenced by latitude. Mangroves are restricted to tropical and subtropical climates due to frost sensitivity. In contrast, salt marshes are dominant in temperate regions, serving as the primary coastal blue

carbon credits. This principle dictates that the greenhouse gas emission reductions or carbon sequestration achieved by the project must be additional. This means the climate benefits would not have occurred without the specific project intervention, funding, and management actions.

191. (C) The IPCC assesses scientific literature but does not conduct its own original research.
The Intergovernmental Panel on Climate Change is a prominent scientific body of the United Nations. A defining characteristic of the IPCC is that it does not conduct original, primary scientific research, nor does it monitor climate data. Instead, it systematically reviews, synthesizes, and assesses peer-reviewed global scientific literature to provide comprehensive assessment reports.

192. (D) Clean Development Mechanism (CDM)
The Clean Development Mechanism was established under the Kyoto Protocol as a flexible cooperative instrument. It was designed to facilitate technology transfer and promote sustainable development in developing nations. By allowing developed countries to fund emission-reduction projects in developing states, it generated certified emission credits that industrialized nations could use to meet targets.

193. (C) 100-300 km
Global Circulation Models are designed to simulate complex atmospheric and oceanic physics across the entire planet. Due to immense computational demands, these models operate at relatively coarse grid resolutions, typically ranging from one hundred to three hundred kilometers. This coarse scale necessitates downscaling techniques to resolve localized coastal oceanography and fisheries impacts.

194. (B) Predation mortality + Catch + Other mortality + Biomass accumulation + Export
In the Ecopath ecosystem modeling suite, mass balance within each functional group is governed by a fundamental conservation equation. It dictates that the total production of a group must equal the sum of all carbon outputs. These outputs include predation mortality, fisheries catch, other natural mortality, biomass accumulation, and net export.

195. (D) Socio-economic factors like wealth, technology, and institutions
In climate change vulnerability frameworks, adaptive capacity represents the internal capability of a community or system to adjust, cope with, and recover from environmental shocks. This capacity is primarily determined by socio-economic factors. Access to financial wealth, diverse technology, strong local governance institutions, and education dictate how effectively fishers adapt to fluctuating resources.

196. (A) Ecological resilience
Maintaining high biodiversity within aquatic ecosystems is a key determinant of ecological resilience. Diverse communities feature functional redundancy, where multiple species perform similar ecological roles. If climate warming drives the decline of a specific species, others can fill its niche, maintaining core ecosystem functions, nutrient cycling, and structural stability under environmental stress.

197. (A) Moving pens to deeper, cooler offshore waters
Climate-smart mariculture focuses on adjusting farming operations to minimize the risks of ocean warming. Moving aquaculture pens to deeper, cooler offshore waters represents a proactive adaptation strategy. This shift exposes cultured species to more stable thermal environments, reduces the risks of thermal stress, and mitigates the occurrences of disease outbreaks and harmful algal blooms.

198. (A) Increased frequency and intensity of extreme weather events
Implementing weather early warning systems is a vital climate adaptation strategy for coastal fishing communities. This technology is designed to address the increased frequency and intensity of extreme weather events like tropical cyclones. By providing timely marine forecasts, these networks allow fishers to secure their gear, avoid hazardous sea conditions, and protect human lives.

199. (D) Precautionary approaches to management
The Food and Agriculture Organization's Code of Conduct for Responsible Fisheries incorporates climate adaptation by promoting precautionary management frameworks. This principle dictates that a lack of absolute scientific certainty

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species for ocean acidification. Because its thin, delicate shell is composed of aragonite, it is highly sensitive to declining carbonate ion concentrations. Acidification drives rapid shell dissolution and structural damage in these organisms, serving as an early warning sign of ecosystem degradation.

257. (C) Degree Heating Weeks (DHW)
Predicting mass coral bleaching requires tracking cumulative thermal stress rather than absolute temperatures. Degree Heating Weeks is a specialized metric designed for this purpose. It integrates both the intensity of sea surface temperature anomalies and their duration over a rolling twelve-week window, serving as a highly reliable predictor of bleaching severity and coral mortality.

258. (B) Oxygen- and Capacity-Limited Thermal Tolerance (OCLTT)
The narrowing of a fish's thermal tolerance window under low-oxygen conditions is a key physiological observation. This response strongly supports the concept of oxygen- and capacity-limited thermal tolerance. The OCLTT hypothesis states that thermal limits are set by the capacity of the cardiorespiratory system to meet metabolic oxygen demands, which are severely constrained under hypoxia.

259. (A) Recruitment failure
When climate change shifts the seasonal timing of plankton blooms, it can desynchronize marine food webs. A phenological mismatch between newly hatched Atlantic mackerel larvae and their primary zooplankton prey means larvae emerge when food is scarce. This mismatch leads to widespread larval starvation, elevated mortality rates, and catastrophic recruitment failure for the fishery.

260. (A) Tropicalization
Tropicalization is an ecological response to ocean warming where native temperate marine communities are reorganized. As seawater temperatures rise, tropical species expand their geographical ranges poleward into temperate zones. These range-expanding tropical herbivores and predators outcompete or overgraze native temperate species, driving shifts in community structure and kelp forest ecosystems.

261. (C) The salinity gradient and flushing times
Estuaries are dynamic coastal systems highly sensitive to changes in precipitation patterns. Altered rainfall changes the volume and timing of freshwater river discharge entering the estuary. This directly shifts the delicate estuarine salinity gradients and alters flushing times, which disrupts the nursery habitats of many commercially important fish and shellfish species.

262. (A) Lower fuel consumption and reduced carbon footprint
In capture fisheries Life Cycle Assessments, the choice of harvesting gear is the primary determinant of environmental impacts. Transitioning from active gears, such as bottom trawls that require continuous engine power to drag nets, to passive gears like longlines or traps significantly reduces vessel fuel consumption. This operational shift directly lowers the overall carbon footprint.

263. (D) Waterlogged, anaerobic soils
Blue carbon ecosystems, such as mangroves and salt marshes, are highly efficient carbon sinks. While they produce substantial biomass, the majority of the sequestered carbon is ultimately stored in their deep, waterlogged soils. The anaerobic conditions of these wet sediments severely restrict microbial decomposition, allowing organic carbon to remain buried and preserved for millennia.

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264. (B) Both A and R are true but R is not the correct explanation of A.
The IPCC Fifth Assessment Report introduced the Representative Concentration Pathways to standardize climate projections, making the assertion true. These RCP scenarios provide time series of greenhouse gas concentrations and radiative forcing, making the reasoning also true. However, the description of what RCPs are does not explain the historical decision to introduce them in AR5.

265. (C) All countries submit Nationally Determined Contributions (NDCs)
The Paris Agreement represented a major shift in international climate policy, superseding the Kyoto Protocol. While Kyoto set binding emissions targets only for developed nations, the Paris Agreement established a universal framework. Under this agreement, all participating

209. (C) Widespread bleaching and significant mortality likely
Degree Heating Weeks is a cumulative thermal stress index used to predict coral bleaching severity. When the DHW value exceeds a critical threshold of eight degree-heating weeks, it indicates extreme thermal stress. At this level, widespread and severe coral bleaching is expected, accompanied by significant mortality of reef-building corals across the affected region.

210. (B) Antarctic Notothenioids
Antarctic Notothenioids are highly specialized polar fish that have evolved in the extremely cold, stable waters of the Southern Ocean for millions of years. Because this environment exhibits minimal seasonal temperature variation, these stenothermal fishes have lost their physiological capacity to cope with thermal shifts, possessing the narrowest thermal tolerance windows of any marine fish.

211. (B) Ocean Deoxygenation
Ocean deoxygenation refers to the systemic decline in the dissolved oxygen content of global oceans. This environmental trend is driven by climate change through two primary mechanisms. Warmer water physically holds less dissolved gas, while increased thermal stratification restricts the vertical mixing that transports oxygen from the surface layers into the deep ocean interior.

212. (A) Range shifts only occur latitudinally, never bathymetrically.
Climate-driven biogeographical range shifts are complex ecological movements as species track their preferred thermal niches. Marine organisms can shift their distributions latitudinally toward the poles, or bathymetrically to deeper water columns where temperatures are cooler. Asserting that range shifts only occur latitudinally and never bathymetrically is scientifically incorrect, making this the false statement.

213. (C) Elevation-dependent warming
High-altitude mountain lakes are warming at rates significantly faster than the global low-elevation average. This amplified warming is driven by elevation-dependent warming. Mechanisms such as snow-albedo feedbacks, changes in cloud cover, and atmospheric water vapor dynamics release more heat at higher elevations, altering the thermal regimes of mountain lakes and cold-water fisheries.

214. (C) A quantified amount of product (e.g., 1 tonne of landed catch)
In Life Cycle Assessment, the functional unit is a critical standardized reference point used to quantify the environmental impacts of a system. For seafood products, this unit is typically defined as a specific weight of product, such as one tonne of landed catch or one kilogram of processed fish fillet, allowing for consistent comparisons.

215. (A) 10-40 times higher per hectare
Seagrass meadows are highly efficient blue carbon ecosystems. Although they occupy a small fraction of the ocean floor, their annual carbon burial rates per hectare are exceptionally high, ranging from ten to forty times higher than those of typical terrestrial forests. This high capacity is driven by rapid growth and slow decomposition in anaerobic soils.

216. (B) Sustainability and low challenges to mitigation and adaptation
The Shared Socioeconomic Pathways are future scenarios used in IPCC assessments. SSP1 represents a green road of global development, characterized by a strong focus on sustainability. This pathway features low challenges to both climate change mitigation and adaptation, driven by rapid technology deployment, low resource intensity, and a transition toward equitable, low-carbon economies.

217. (C) Emissions Trading Systems (Cap-and-Trade)
Emissions Trading Systems, commonly known as cap-and-trade, are market-based instruments designed to reduce global greenhouse gas emissions. These systems set an absolute limit, or cap, on total emissions while issuing tradeable allowances. This allows industries to buy and sell credits, utilizing market forces to achieve cost-effective emission reductions across different sectors.

218. (D) Carbon cycle
Earth System Models represent a major technological advancement in climate simulation. While traditional Global Circulation Models focus on physical atmospheric and oceanic dynamics, ESMs integrate interactive biogeochemical processes. By explicitly closing the global carbon cycle, ESMs simulate the complex feedback loops between climate warming, terrestrial vegetation dynamics, and ocean carbon absorption.

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219. (A) Correlative relationships between species presence and environmental variables
Species Distribution Models are frequently used to project range shifts, but they face scientific criticism. This is because they primarily rely on statistical correlations between historical species presence records and environmental spatial layers. These correlative models often ignore critical biological processes, such as physiological adaptations, dispersal limitations, and biotic interactions like predation.

220. (A) I, II, III and V
Standard climate vulnerability assessments for fisheries follow a systematic, multi-step process. First, the scope and objectives are defined. Next, researchers assess exposure to climate hazards and biological sensitivity. They then evaluate the socio-economic adaptive capacity of communities, culminating in calculating a vulnerability index. Implementing immediate geoengineering is not a standard assessment step, making statement IV incorrect.

221. (B) Ecological phase or regime
When a coral reef is subjected to persistent climate stress, it can cross a critical ecological threshold. This triggers a sudden transition from a coral-dominated state to an alternative stable state dominated by fleshy macroalgae. This dramatic reorganization represents an ecological phase or regime shift, which alters habitat structure and collapses reef fisheries.

222. (A) Main propulsion engine
Energy audits conducted on commercial fishing vessels systematically analyze fuel consumption across different systems. These audits consistently identify the main propulsion engine as the primary consumer of fossil fuels, responsible for the vast majority of diesel burned during searching and dragging. Consequently, engine efficiency is the primary target for fleet decarbonization.

223. (C) Reduce socio-economic vulnerability to climate-induced fishery failures
Livelihood diversification is a proactive climate adaptation strategy implemented in coastal fishing communities. By encouraging fishers to develop alternative income sources, such as aquaculture, tourism, or agriculture, household economics are decoupled from fluctuating marine resources. This diversification directly reduces the socio-economic vulnerability of families to climate-induced collapses in local capture fisheries.

224. (D) High-altitude aquatic and terrestrial habitats
India's National Action Plan on Climate Change established the National Mission for Sustaining the Himalayan Ecosystem. This specific mission is designed to monitor and safeguard the unique Himalayan region from climate impacts. It addresses critical issues such as glacial retreat, altered hydrology, and biodiversity loss, protecting high-altitude aquatic resources and mountain communities.

225. (C) Water vapor
While carbon dioxide and methane are the primary drivers of anthropogenic climate change, water vapor is the most abundant greenhouse gas in the atmosphere. It plays a major role in the natural greenhouse effect. However, its concentration is governed by temperature feedbacks rather than direct human emissions, as warmer air holds more moisture, amplifying warming.

226. (B) Colder and more dense
The ocean's solubility pump is a physical-chemical mechanism that transports dissolved inorganic carbon from the surface to the deep ocean. This pump operates most efficiently in polar regions where surface waters become cold and dense. Colder water physically holds more dissolved carbon dioxide, which is transported downward as these dense water masses sink.

227. (D) Satellite Altimetry
Global sea-level rise is monitored with high precision using satellite altimetry. This spaceborne technology measures the time it takes for a radar pulse to travel from the satellite to the sea surface and back. By combining these measurements with precise orbital tracking, scientists can calculate global sea-surface height changes over decadal timescales.

228. (D) 90 degrees to the right
Ekman transport is a physical oceanographic process driven by the wind and the Earth's rotation. As wind blows across the ocean surface, the Coriolis effect deflects water movement. In the Northern Hemisphere, this net transport of water in the upper ocean layer is deflected at an

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angle of ninety degrees to the right of the wind direction.

229. (C) La Niña
La Niña is the cold phase of the El Niño-Southern Oscillation climate pattern. It is characterized by a prolonged period of anomalously negative sea surface temperatures in the central and eastern equatorial Pacific. This oceanic cooling is driven by intensified easterly trade winds that enhance the upwelling of cold, deep waters off South America.

230. (A) I, II, III
Climatic phenomena operate across vastly different temporal scales. An individual El Niño event is an interannual phenomenon, typically lasting nine to twelve months. The Pacific Decadal Oscillation operates on multi-decadal scales, with phases persisting for twenty to thirty years. In contrast, Milankovitch cycles are astronomical variations operating over tens of thousands of years.

231. (D) Less alkaline, moving towards neutrality
The term ocean acidification describes a chemical trend rather than the ocean becoming an actual acid. Average surface seawater is naturally alkaline, with a pre-industrial pH of approximately eight point two. As seawater absorbs carbon dioxide, pH declines toward seven, meaning the ocean is becoming less alkaline and moving closer to chemical neutrality.

232. (B) Enhanced formation of marine halite (salt)
Ocean acidification reduces the concentration of dissolved carbonate ions in seawater. This chemical shift directly decreases calcification rates in corals, promotes the dissolution of existing aragonite shells, and weakens pteropod shells. It does not influence the physical crystallization of sodium chloride, making the enhanced formation of marine halite an incorrect consequence of acidification.

233. (C) Photosynthetically Active Radiation
In coral reef ecology, PAR stands for Photosynthetically Active Radiation. This term designates the spectral range of solar light, from four hundred to seven hundred nanometers, that photosynthetic organisms can use for photosynthesis. Under elevated temperatures, high PAR exacerbates cellular damage in Symbiodiniaceae, triggering reactive oxygen species production and coral bleaching.

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234. (D) Collapse of aerobic energy generation
Under the oxygen- and capacity-limited thermal tolerance theory, fish mortality at critical thermal limits is driven by cardiorespiratory failure. As temperatures increase, tissue oxygen demands rise exponentially, but the cardiovascular system cannot deliver oxygen fast enough. This mismatch creates an oxygen deficit, causing a collapse of aerobic energy generation and subsequent cellular death.

235. (A) Differential temperature responses between trophic levels
Match-mismatch dynamics are highly sensitive to climate change because different trophic levels respond unequally to warming. While phytoplankton blooms may shift rapidly in response to warming sea temperatures, zooplankton grazing or fish larval hatching might rely on different cues. This differential temperature sensitivity desynchronizes food webs, causing larval starvation and recruitment failure.

236. (B) Ocean warming and altered current patterns
The geographical expansion of the invasive lionfish across the western Atlantic and Caribbean has been significantly facilitated by climate change. Ocean warming has expanded the thermal habitat suitable for this tropical predator, while altered ocean current patterns have transported its pelagic larvae into new, higher-latitude temperate regions where they can now survive and establish populations.

237. (B) Reduced snowmelt and altered river discharge regimes
High-altitude cold-water fisheries face unique vulnerabilities compared to marine systems. These mountain habitats are highly dependent on cryospheric water sources. Rising global temperatures cause rapid glacial retreat, reduced winter snowpack, and altered snowmelt timings. This shifts regional river discharge regimes, causing low summer flows, elevated stream temperatures, and habitat fragmentation for trout and salmon.

regarding climate impacts should not be used as a reason to postpone management actions. It advocates for conservative harvest limits to safeguard vulnerable marine resources.

200. (A) Both A and R are true and R is the correct explanation of A.
Marine protected areas serve as highly effective tools for climate change adaptation, making the assertion correct. By prohibiting destructive human activities like overfishing within their boundaries, MPAs protect critical habitats, maintain high biodiversity, and preserve ecological refugia. This reduction in local stressors directly enhances the overall resilience of ecosystems to cope with global warming.

201. (C) Carbon dioxide
While various greenhouse gases exhibit higher specific warming potentials, carbon dioxide is released in massive volumes through human industrial activities. The burning of fossil fuels, industrial processing, and global deforestation generate immense quantities of this gas. Consequently, carbon dioxide accounts for the largest cumulative percentage of the anthropogenic greenhouse effect on the planet.

202. (D) Partial pressure of CO_2 (pCO_2) between the air and sea surface
The transfer of carbon dioxide across the air-sea interface is a physical-chemical diffusion process. This gas exchange is driven by the gradient in the partial pressure of carbon dioxide between the atmosphere and the surface ocean. When atmospheric partial pressure exceeds that of surface waters, carbon dioxide dissolves into the ocean to establish thermodynamic equilibrium.

203. (A) Glacial isostatic adjustment (rebound)
In regions like Scandinavia and northern Canada, local sea levels are falling despite global sea-level rise. This localized trend is driven by glacial isostatic adjustment. Since the last ice age, the removal of heavy ice sheets has allowed the Earth's crust to slowly rebound upward. This vertical crustal uplift exceeds the rate of global sea-level rise.

204. (B) Freshening of the North Atlantic from melting Greenland ice
The Atlantic Meridional Overturning Circulation is driven by the sinking of cold, dense, and saline waters in the subpolar North Atlantic. Climate change is accelerating the melting of the Greenland ice sheet, discharging massive volumes of freshwater. This freshening reduces surface water density, preventing it from sinking and subsequently weakening this vital heat-transporting conveyor belt.

205. (B) Tahiti and Darwin
The Southern Oscillation Index is a standardized meteorological metric used to monitor the atmospheric component of the El Niño-Southern Oscillation. It is calculated based on the monthly sea-level pressure differences between Tahiti, representing the subtropical eastern Pacific high-pressure zone, and Darwin, representing the equatorial western Pacific low-pressure zone, tracking zonal wind shifts.

206. (A) PDO
The Pacific Decadal Oscillation is a prominent, long-term climate variability pattern. Although it influences global weather, it is most strongly expressed in the North Pacific Ocean basin. The PDO is characterized by widespread sea surface temperature anomalies in this region, which shift on multi-decadal cycles of twenty to thirty years, shaping marine food webs.

207. (C) Decreasing the absorption of low-frequency sound, making the ocean noisier
Ocean acidification alters the physical chemical properties of seawater, which impacts marine acoustics. The chemical dissolution of boric acid, which is a key sound-absorbing ion in the ocean, decreases with declining pH. This reduction in acidity decreases the absorption of low-frequency sound waves, allowing underwater sound to travel further and making the ocean noisier.

208. (D) It can alter neurotransmitter function, impairing olfaction and behavior in fish.
Ocean acidification impacts marine life beyond structural calcification. In non-calcifying organisms, such as teleost fish, the absorption of carbon dioxide alters internal acid-base chemistry. This physiological change disrupts GABAA neurotransmitter receptor function in the brain, impairing larval fish olfaction, predator detection, homing behaviors, and overall survival on coral reefs, making this statement correct.

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247. (B) Adjusting fishing closures in real-time based on environmental conditions and species distributions
Climate-smart fisheries management requires transitioning from rigid, static spatial boundaries to dynamic spatial management. Because ocean warming drives rapid shifts in fish distributions and seasonal spawning timings, static marine reserves are ineffective. Dynamic management involves adjusting fishing closures in real-time based on current environmental conditions and satellite-tracked species distributions.

248. (A) Shared responsibility and authority between government agencies and local resource users
Co-management is a fisheries governance framework strongly advocated by the Food and Agriculture Organization for climate adaptation. It is defined as a partnership arrangement where government agencies and local resource users, such as fishers and coastal communities, share the responsibility and authority for managing local marine resources, enhancing decision-making flexibility and resilience.

249. (C) N_2O
Nitrous oxide is a highly potent greenhouse gas with a high global warming potential. In coastal marine ecosystems, its emissions are heavily linked to agricultural runoff containing synthetic nitrogen fertilizers. This excess nitrogen enters estuaries and coastal waters, where it undergoes microbial nitrification and denitrification under low-oxygen conditions, releasing substantial nitrous oxide into the atmosphere.

250. (D) The solubility of CO_2 in water decreases with increasing temperature
The global ocean acts as a vital carbon sink, absorbing atmospheric emissions. However, this carbon sink capacity is projected to decrease as ocean temperatures rise. This decline is driven by physical chemistry, as the solubility of carbon dioxide in water decreases with increasing temperature, limiting the physical absorption of gas by warming surface waters.

251. (A) Localized vertical movements of the Earth's crust
Isostatic sea-level changes are physically distinct from eustatic changes. While eustatic changes are global variations driven by water mass additions or thermal expansion, isostatic changes are localized vertical movements of the Earth's crust. These crustal movements, such as post-glacial rebound or tectonic subsidence, alter the relative sea level along specific coastlines.

252. (A) P-II, Q-III, R-I, S-IV
Global ocean circulation patterns are driven by distinct physical mechanisms. Deep thermohaline circulation is driven by density gradients. Surface gyres are shaped by wind systems and the Coriolis force. Equatorial upwelling occurs due to trade wind divergence. Coastal upwelling is generated when winds blow parallel to the coast, driving offshore Ekman transport, matching each circulation.

253. (B) Drought conditions in Indonesia and Australia
During El Niño events, the atmospheric Walker Circulation weakens, flattening the sea surface temperature gradient across the equatorial Pacific. This meteorological shift suppresses the normal convective precipitation over the western Pacific warm pool. Consequently, regions like Indonesia and northern Australia experience severe drought conditions and increased forest fire risks, altering terrestrial and freshwater hydrology.

254. (A) Bottom-up control driven by climate variability
The catastrophic collapse of the Peruvian anchoveta fishery during strong El Niño events is a classic example of bottom-up ecological control. When the warm ENSO phase suppresses nutrient upwelling, primary production collapses. This sudden loss of phytoplankton food propagates up the food web, starving the anchoveta population and demonstrating how climate drives ecosystem productivity.

255. (C) Saturation state of calcium carbonate
The thermodynamic propensity for marine calcifying organisms to build or dissolve their shells is governed by this mathematical formula. This equation defines the saturation state, represented by omega, of calcium carbonate. It calculates the ratio of the product of dissolved calcium and carbonate ion concentrations to the apparent stoichiometric solubility product in seawater.

256. (D) Pteropod (Limacina helicina)
The pteropod Limacina helicina is a small pelagic sea snail widely considered an indicator

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followed by the sinking of particulate organic matter, effectively sequestering atmospheric carbon dioxide in the deep ocean.

275. (D) Saltwater intrusion
Sea-level rise poses a severe threat to coastal groundwater resources, which are vital for coastal agriculture and aquaculture. As sea levels rise, the hydrostatic pressure of seawater increases, pushing saline water inland into freshwater aquifers. This saltwater intrusion contaminates coastal wells and ponds, altering water chemistry and disrupting freshwater aquaculture production.

276. (A) P-III, Q-IV, R-I, S-II
Climatic and oceanographic processes are governed by distinct physical principles. Albedo represents the reflectivity of a surface. Steric changes are density-driven volume adjustments in seawater. Advection refers to the horizontal transport of heat or water masses by currents. Sequestration represents the long-term capture and storage of carbon, mapping each term to its physical process.

277. (B) Reduction of available nesting area and increased egg inundation
Sea-level rise threatens coastal biodiversity, particularly beach-nesting marine species like sea turtles. Rising water levels and increased storm surges erode sandy beaches, reducing the available nesting area. Additionally, higher sea levels cause frequent inundation of nests by saltwater, which suffocates developing embryos, lowers hatching success, and directly threatens turtle populations.

278. (A) North Pacific
The Pacific Decadal Oscillation is a prominent, long-term climate variability pattern. Although it influences global weather, it is most strongly expressed in the North Pacific Ocean basin. The PDO is characterized by widespread sea surface temperature anomalies in this region, which shift on multi-decadal cycles of twenty to thirty years, shaping marine food webs.

279. (B) Bicarbonate ions
Ocean acidification alters the chemical equilibrium of dissolved inorganic carbon in seawater. When anthropogenic carbon dioxide dissolves, it reacts with water to form carbonic acid, which dissociates into hydrogen ions. These free hydrogen ions react with carbonate ions to form bicarbonate ions. Consequently, this chemical buffering process increases the concentration of bicarbonate ions.

280. (C) 1.0
The saturation state of aragonite, a soluble polymorph of calcium carbonate, determines whether shells dissolve or precipitate. When this value is greater than one, seawater is supersaturated, favoring calcification. However, when the aragonite saturation state falls below a critical threshold of one, seawater becomes undersaturated and corrosive, accelerating the dissolution of coral frameworks.

281. (C) Reactive Oxygen Species (ROS)
Coral bleaching is a cellular stress response driven by elevated temperatures and high solar light. This environmental stress damages the photosynthetic apparatus of symbiotic zooxanthellae. This disruption halts normal photosynthesis and triggers the excessive production of highly toxic reactive oxygen species within host tissues, forcing the coral to expel its symbionts.

282. (B) 2.0 to 3.0
The Q10 temperature coefficient is a physiological metric used to quantify the temperature sensitivity of metabolic rates in ectothermic organisms like fish. For most biological and biochemical processes in temperate and tropical fishes, this value typically ranges from two point zero to three point zero, meaning metabolic rates double or triple with every ten-degree warming.

283. (A) Energy between trophic levels
A phenological mismatch occurs when climate change shifts the seasonal timing of interacting species unequally. In marine food webs, this desynchronization typically occurs between phytoplankton blooms and larval fish hatching. This temporal mismatch deprives young larvae of essential food, disrupting the efficient transfer of energy between trophic levels and leading to recruitment failure.

284. (B) Higher latitudes
Mobile pelagic fish species are highly sensitive to seawater temperatures, which dictate their metabolic performance. As global ocean temperatures rise due to climate change, many species shift their geographical distributions.

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countries, both developed and developing, are required to submit and progressively strengthen their Nationally Determined Contributions to mitigate warming.

266. (D) Global Circulation Model (GCM)
Simulating physical oceanographic and atmospheric processes on a global scale requires complex, physics-based computer models. A Global Circulation Model is designed specifically for this purpose. GCMs solve fundamental mathematical equations governing fluid dynamics, thermodynamic energy transfer, and radiation balance, providing long-term projections of global sea surface temperatures, currents, and salinity regimes under climate change.

267. (A) Species Distribution Modeling (SDM)
Species Distribution Modeling is a scientific framework used to predict biogeographical shifts. The core principle involves statistically correlating known species occurrence data with environmental spatial layers, such as temperature and salinity, to define the species' environmental niche. This niche is then projected onto future climate scenarios to map potential geographical range shifts.

268. (B) The presence of people, livelihoods, or assets in places that could be adversely affected
In IPCC vulnerability frameworks, exposure is a key component of climate risk. It refers specifically to the presence of people, livelihoods, coastal infrastructure, or marine ecosystems in geographic areas that could be adversely affected by climate hazards. Exposure maps where climatic stressors, such as sea-level rise or storm surges, physically overlap with human and natural assets.

269. (B) Resilience
Resilience represents the capacity of a social-ecological system, such as a coastal fishery, to tolerate disturbances. A highly resilient system can absorb environmental shocks, such as marine heatwaves or extreme storms, and reorganize while retaining its basic structure, functional processes, and feedback loops, preventing a catastrophic transition into a permanently degraded state.

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270. (A) Fleet decarbonization / Mitigation
Capture fisheries can reduce their carbon footprint by adopting energy recovery technologies. Utilizing waste heat recovery systems on fishing vessels captures thermal energy from engine exhaust to generate auxiliary onboard electricity. This reduces the demand on diesel generators, lowering overall fuel consumption and associated greenhouse gas emissions, serving as a mitigation strategy.

271. (C) Deepening aquaculture ponds to maintain water volume
Inland aquaculture operations face severe risks from climate-induced altered hydrological cycles, including prolonged dry seasons and elevated temperatures. A practical adaptation strategy is deepening aquaculture ponds. This physical modification helps maintain adequate water volume, buffers against rapid temperature spikes, and prevents dissolved oxygen depletion, securing fish survival during dry spells.

272. (D) Preparedness, early warning, and building resilient infrastructure
Disaster Risk Reduction frameworks in coastal fisheries focus on proactive risk management to protect communities from extreme weather. These strategies prioritize disaster preparedness, implementing early warning communication networks, and building resilient coastal infrastructure. This reduces the vulnerability of fishing fleets and processing facilities, safeguarding human lives and securing coastal seafood supply chains.

273. (B) Small pelagic fish (e.g., sardines)
Life cycle assessments of global protein sources reveal highly variable carbon footprints. Producing land-based livestock like beef or lamb generates substantial greenhouse gas emissions. In contrast, harvesting wild small pelagic fish, such as sardines or anchovies, using efficient purse seines consumes minimal fuel per unit of catch, resulting in an exceptionally low greenhouse gas footprint.

274. (B) The biological pump
The biological carbon pump is an organic carbon transport mechanism in marine ecosystems. It actively transports carbon from the surface ocean to the deep ocean interior against the concentration gradient. This biological process begins with primary production by phytoplankton,

238. (A) Direct emissions from owned or controlled sources (e.g., vessel fuel)
In greenhouse gas accounting frameworks used in fisheries Life Cycle Assessments, Scope one emissions represent direct emissions. These are greenhouse gases released directly from sources that are owned or controlled by the fishing operation. The primary source of Scope one emissions in capture fisheries is the combustion of marine diesel in the vessel's propulsion engine.

239. (C) Reducing Emissions from Deforestation and Forest Degradation (REDD+)
National climate mitigation strategies increasingly incorporate blue carbon ecosystem conservation. Under the United Nations Framework Convention on Climate Change, these coastal carbon sinks are integrated into policy frameworks like Reducing Emissions from Deforestation and Forest Degradation. REDD+ provides financial incentives for developing countries to protect mangroves and wetlands, securing their vast sediment carbon pools.

240. (D) Both A and R are false.
Representative Concentration Pathways are greenhouse gas trajectory scenarios used to input radiative forcing pathways into climate models. They do not dictate specific socio-economic policies that nations must adopt, nor are they policy-prescriptive frameworks mandated by the United Nations. Because they are strictly descriptive scientific tools rather than prescriptive policy mandates, both statements are false.

241. (C) Submit progressively more ambitious Nationally Determined Contributions (NDCs) every five years
A defining feature of the Paris Agreement is its ratchet mechanism, designed to increase global climate ambition over time. Under this policy framework, participating countries are legally required to submit updated Nationally Determined Contributions every five years. Each successive submission must represent a progression beyond previous targets, reflecting the country's highest possible mitigation ambition.

242. (B) Ecopath with Ecosim (EwE)
Evaluating the complex food web impacts of climate change requires trophic network modeling rather than single-species assessments. Ecopath with Ecosim is a highly effective ecological modeling suite for this purpose. EwE represents the trophic linkages among functional groups, allowing scientists to simulate how climate-driven primary production shifts propagate through predators and fisheries.

243. (D) Dynamical downscaling
Dynamical downscaling is a computationally intensive modeling technique used to bridge the spatial gap between global models and regional needs. This approach runs high-resolution Regional Climate Models over a specific study area. These localized models are nested within and driven by the boundary conditions simulated by coarse Global Circulation Models, resolving regional weather and coastal currents.

244. (A) Biological sensitivity, physical exposure, and socio-economic adaptive capacity indices
A rigorous quantitative vulnerability assessment of a fishery integrates three core dimensions. It combines indices of physical exposure, representing the intensity of climate hazards; biological sensitivity, reflecting the target species' thermal limits; and socio-economic adaptive capacity, indicating the fishers' capability to cope with resource fluctuations, providing a comprehensive vulnerability score.

245. (C) The combined stress of overfishing, nutrient pollution, and ocean warming
Ecological resilience is often eroded not by a single event, but by the cumulative impacts of multiple stressors. A classic example in marine ecosystems is the combined stress of commercial overfishing, coastal nutrient runoff, and global ocean warming. These co-occurring pressures degrade ecosystems, reducing their capacity to absorb anomalies and accelerating phase shifts.

246. (A) Mitigation
Adopting energy-efficient hull designs, such as bulbous bows or optimized hull coatings, is a practical technology used in commercial fisheries. These engineering modifications reduce hydrodynamic drag as the vessel moves through water, decreasing the fuel required for propulsion. This directly lowers marine diesel consumption and associated carbon dioxide emissions, serving as a mitigation strategy.

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They actively migrate toward higher latitudes or deeper waters to track their preferred cooler thermal niches, altering regional fisheries and ecosystem structures.

285. (B) Coastal squeeze blocking landward migration
Mangrove forests are vulnerable to rapid sea-level rise if they cannot adapt spatially. Naturally, mangroves migrate landward as water levels rise. However, in heavily developed coastal areas, this landward migration is physically blocked by anthropogenic infrastructure like seawalls and roads. This coastal squeeze traps and drowns the forest, destroying critical fisheries habitats.

286. (A) Global warming potential (GWP) footprint
In fisheries Life Cycle Assessments, fossil fuel combustion is the primary contributor to greenhouse gas emissions. Improving vessel fuel efficiency directly reduces the volume of marine diesel burned during searching and harvesting operations. This operational efficiency decreases the release of carbon dioxide and other greenhouse gases, lowering the overall global warming potential footprint.

287. (C) Coastal and marine vegetated ecosystems
The term blue carbon refers specifically to the organic carbon sequestered and stored by vegetated coastal and marine ecosystems. This carbon capture is driven primarily by seagrass meadows, mangrove forests, and salt marshes. These habitats trap organic matter in their waterlogged, anaerobic soils, preventing decomposition and storing carbon for centuries.

288. (D) Policy-relevant but not policy-prescriptive
A core operating principle of the Intergovernmental Panel on Climate Change is to maintain scientific neutrality. The IPCC is mandated to produce assessments that are policy-relevant but not policy-prescriptive. This means reports must provide rigorous scientific projections and adaptation options for decision-makers without endorsing specific political policies or mandating legislative actions.

289. (B) 1.5°C
The Paris Agreement is a legally binding international treaty designed to address global warming. Its central goal is to limit the increase in global average temperature to well below two degrees Celsius above pre-industrial levels. It explicitly emphasizes pursuing efforts to limit this warming to one point five degrees Celsius, reducing severe climate risks.

290. (B) I, II, III and IV
Earth System Models represent a major advancement in climate modeling. Unlike traditional models that only simulate physical atmospheric and ocean circulation, ESMs incorporate land surface processes and global biogeochemical cycles. By integrating the biosphere with physical oceanography and meteorology, ESMs simulate how carbon moves through terrestrial, marine, and atmospheric systems, making all components correct.

291. (D) Environmental spatial data layers
Species Distribution Models are mathematical tools used to project habitat suitability under climate change. These models are built by statistically linking known species occurrence records, such as geographic coordinates, with environmental spatial data layers like temperature, salinity, and depth. This allows researchers to define the species' environmental niche and map potential range shifts.

292. (A) High sensitivity
In climate vulnerability frameworks, sensitivity represents the internal fragility of a community to climate shocks. A coastal community whose local economy is heavily dependent on harvesting a single, climate-sensitive fish stock possesses high sensitivity. If that specific fishery collapses due to warming, the community has no alternative resources, amplifying the economic impact.

293. (C) A small additional stressor can cause a massive, rapid ecosystem shift
Ecological tipping points represent non-linear thresholds in ecosystem responses to climate change. When a system is subjected to cumulative pressures, it can approach this critical boundary. Once reached, a minor additional stressor triggers a rapid, self-reinforcing, and often irreversible shift in ecosystem structure, transitioning the system into a degraded alternative stable state.

294. (A) Natural refrigerants like ammonia or CO_2
Climate change mitigation in post-harvest fisheries can be achieved by upgrading onboard refrigeration systems. Traditional cooling systems utilize chemical refrigerants with exceptionally high global warming potentials. Transitioning to natural refrigerants, such as ammonia or carbon

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2015
9. The Maritime Zones of India (Regulation of Fishing by Foreign Vessels) Act (1981) strictly prohibits foreign vessels from:
(A) Navigating through the contiguous zone
(B) Fishing in the Indian EEZ without a valid license or permit
(C) Boarding Indian coast guard ships
(D) Reporting catch data to their flag state

2014
10. Consider the following statements regarding the Biological Diversity Act (2002):
I. It establishes the National Biodiversity Authority.
II. It abolishes state-level biodiversity boards.
III. It regulates access to biological resources and associated knowledge.
Which of the above statement(s) is/are CORRECT?
(A) I and III
(B) I and II
(C) II and III
(D) I only

2012
11. In the Coastal Regulation Zone (CRZ) notifications, CRZ-I is specifically designated for:
(A) Ecologically sensitive areas and geomorphological features
(B) Development of large-scale aquaculture ponds
(C) Heavily populated urban coastal areas
(D) Existing municipal limits with high infrastructure

2007
12. The National Policy on Marine Fisheries (NPMF 2017) emphasizes which principle for marine resource extraction?
(A) Unregulated fleet expansion
(B) Privatization of territorial waters
(C) Sustainable practices and ecosystem approaches
(D) Maximum biological yield without limits

2013
13. What is a core mandate of the Marine Products Export Development Authority (MPEDA) Act (1972)?
(A) Regulating inland capture fisheries
(B) Enforcing the monsoon trawl ban
(C) Establishing water quality parameters for lakes
(D) Setting quality control standards for seafood exports

2002
14. In the context of the Marine Stewardship Council (MSC), what does chain of custody certification ensure?
(A) Complete elimination of bycatch
(B) Fixed market pricing for certified products
(C) Seafood traceability from certified fishery to consumer
(D) Prohibition of exported seafood

2013
15. The Port State Measures Agreement (PSMA) primarily aims to combat IUU fishing by:
(A) Subsidizing port fees for foreign vessels
(B) Preventing vessels engaged in IUU fishing from using ports and landing catches
(C) Expanding open-access fishing in international waters
(D) Removing catch documentation schemes

2021
16. Under UNCLOS (1982), the high seas are characterized by:
(A) Total jurisdiction of adjacent coastal states
(B) Complete prohibition of scientific research
(C) Exclusive rights for flag states to mine the seabed
(D) Freedom of fishing subject to treaty obligations and conservation duties

2003
17. The United Nations Fish Stocks Agreement (UNFSA) focuses primarily on the conservation of:
(A) Straddling and highly migratory fish stocks
(B) Inland riverine fisheries
(C) Benthic sedentary species on the continental shelf
(D) Deep-sea hydrothermal vent organisms

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2002
18. The FAO Code of Conduct for Responsible Fisheries (CCRF) is best described as:
(A) A mandatory global treaty with penal sanctions
(B) A localized agreement for Mediterranean states
(C) A voluntary framework integrating the ecosystem approach to fisheries
(D) An annex to the Convention on Biological Diversity

CHAPTER 10
Fisheries Legislations and Regulations

2024
1. According to the Tragedy of the Commons, what is the primary consequence of open access in unregulated fisheries?
(A) Overcapitalization and resource depletion
(B) Maximization of individual long-term profit
(C) Equal distribution of harvest among vessels
(D) Spontaneous establishment of catch quotas

2006
2. Under UNCLOS, what is the maximal breadth of the Contiguous Zone measured from the baseline?
(A) 12 nautical miles
(B) 20 nautical miles
(C) 24 nautical miles
(D) 350 nautical miles

2001
3. Within the Exclusive Economic Zone (EEZ), the coastal state exercises which of the following rights?
(A) Sovereign rights for exploring and exploiting natural resources
(B) Absolute territorial sovereignty over the high seas
(C) Complete control over innocent passage of foreign military vessels
(D) Prohibition of deep-sea cables laid by other states

2012
4. Match the sections of the Indian Fisheries Act (1897) in List I with their corresponding contexts in List II:
List I: (Section)
P. Section 4
Q. Section 5
R. Section 6
S. Section 7
List II: (Context)
1. Prohibition on use of explosives
2. Prohibition on use of poisons
3. Power of state government to make rules
4. Arrest without warrant for specific offenses
(A) P-2, Q-3, R-4, S-1
(B) P-4, Q-3, R-1, S-2
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-2, R-3, S-4

2008
5. Which primary management measure is implemented annually under state Marine Fishing Regulation Acts (MFRA) to protect breeding fish stocks?
(A) Total allowable catch quotas
(B) The monsoon trawl ban
(C) Mandatory turtle excluder devices
(D) Ban on artisanal gillnets

2023
6. The Murari Committee recommendations regarding India's Deep Sea Fishing Policy primarily advocated for:
(A) Increasing foreign joint ventures in territorial waters
(B) Exclusively promoting artisanal fishing in the high seas
(C) Rescinding licenses of foreign vessels operating in the EEZ
(D) Scrapping all deep-sea fishing regulations

2014
7. Under the Environmental (Protection) Act (1986), coastal pollution control heavily emphasizes which parameter for aquaculture effluent discharge?
(A) Dissolved oxygen saturation above 12 mg/L
(B) Absolute zero nitrogen release
(C) Complete ban on freshwater usage
(D) Biochemical Oxygen Demand (BOD) limits

2023
8. Which of the following marine groups is afforded highest protection under Schedule I of the Wildlife (Protection) Act (1972)?
(A) All marine elasmobranchs
(B) Coastal pelagic clupeids
(C) Certain species of marine turtles and cetaceans
(D) Cultured penaeid shrimps

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(B) Fishers avoid all regulatory frameworks
(C) Consumers can identify products derived from sustainable fisheries
(D) Only farmed fish are permitted for sale

2004
67. Which term refers to the practice of registering a merchant ship in a country other than that of the ship's owners to avoid regulations or taxes?
(A) Flag of Convenience
(B) Port State Control
(C) Cabotage
(D) Innocent Passage

2019
68. Consider the following statements of Assertion (A) and Reason (R) and select the correct answer:
Assertion (A): UNCLOS grants coastal states total jurisdiction over the high seas.
Reason (R): The high seas are considered the common heritage of mankind and subject to freedom of fishing with conservation duties.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2010
69. For straddling fish stocks, the UNFSA mandates that coastal states and states fishing on the high seas must:
(A) Cooperate directly or through RFMOs to ensure conservation
(B) Compete without restrictions to maximize yield
(C) Prohibit any fishing of these stocks indefinitely
(D) Exclude scientific data from quota allocations

2006
70. Consider the following statements concerning the FAO Code of Conduct for Responsible Fisheries (CCRF):
I. It is a legally binding international treaty.
II. It promotes the ecosystem approach to fisheries.
III. It covers both capture fisheries and aquaculture.
Which of the above statement(s) is/are CORRECT?
(A) II and III
(B) I and II
(C) I and III
(D) I only

2013
71. Under CITES, Appendix III includes species that:
(A) Are threatened with global extinction
(B) Are protected in at least one country, which has requested assistance in controlling trade
(C) Require no export permits whatsoever
(D) Are extinct in the wild

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2022
72. Memorandums of Understanding (MoUs) under the CMS for marine turtles primarily facilitate:
(A) Unregulated commercial harvest
(B) The establishment of strictly national marine parks without regional cooperation
(C) Coordinated international conservation and management plans
(D) Eradication of turtle habitats for port development

2001
73. Criteria for identifying Wetlands of International Importance (Ramsar sites) include:
(A) Complete absence of aquatic flora
(B) Being entirely man-made concrete structures
(C) Having no hydrological connection to other water bodies
(D) Supporting vulnerable, endangered, or critically endangered species

2022
74. Prevention of fishing gear disposal into the sea under MARPOL Annex V aims to mitigate which severe marine issue?
(A) Ghost fishing
(B) Eutrophication
(C) Thermal pollution
(D) Acoustic disturbance

2024
75. The Southern Ocean Whale Sanctuary was established by the IWC to:
(A) Increase commercial whaling quotas
(B) Protect feeding grounds and prohibit commercial whaling in the area
(C) Promote eco-tourism solely
(D) Eradicate krill populations

2010
76. Stock allocations by Regional Fisheries Management Organizations (RFMOs) are typically based on:
(A) Alphabetical order of member states

2023

19. Under CITES, Appendix I lists threatened aquatic species that:
(A) Are threatened with extinction and subject to strict commercial trade bans
(B) Are subject to unlimited commercial trade
(C) Require only a certificate of origin for export
(D) Are not globally threatened but protected locally

2025

20. Consider the following statements regarding the Convention on Migratory Species (CMS):
I. It is also known as the Bonn Convention.
II. It covers only terrestrial avian species.
III. It facilitates binding agreements and MoUs for aquatic species.
IV. It enforces global total allowable catch limits for tunas.
Which of the above statement(s) is/are INCORRECT?
(A) I and III
(B) I, II and IV
(C) II, III and IV
(D) II and IV

2013

21. Under the Ramsar Convention, which concept guides the sustainable management of wetland ecosystems?
(A) Maximum Sustainable Yield
(B) Wise-use principle
(C) Complete human exclusion
(D) Unrestricted urban reclamation

2014

22. Annex V of the MARPOL Convention specifically regulates the prevention of pollution by:
(A) Noxious liquid substances in bulk
(B) Harmful substances carried in packaged form
(C) Garbage, including the disposal of plastic fishing gear
(D) Oil discharge from machinery spaces

2003

23. The International Whaling Commission (IWC) provides exemptions for which type of whaling?
(A) Commercial pelagic whaling
(B) Scientific research solely for profit
(C) Unregulated open-access whaling
(D) Aboriginal subsistence whaling

2022

24. The Indian Ocean Tuna Commission (IOTC) functions primarily as a:
(A) Regional Fisheries Management Organization (RFMO)
(B) Sub-regional NGO
(C) Global marine policing authority
(D) Certification body for aquaculture

2010

25. The Bay of Bengal Programme (BOBP-IGO) focuses fundamentally on:
(A) Enforcing deep-sea mining regulations
(B) Promoting artisanal coastal fisheries and capacity-building
(C) Managing global whaling quotas
(D) Setting inland water pollution standards

2016

26. Which underlying assumption characterizes the "Tragedy of the Commons" in fisheries?
(A) Fishers will voluntarily limit catch to ensure long-term sustainability
(B) A rational fisher will increase effort because the cost of depletion is shared by all
(C) State regulation always fails to prevent overfishing
(D) Market forces automatically adjust to prevent stock collapse

2025

27. The Territorial Sea baseline is primarily defined as the:
(A) Low-water line along the coast as marked on large-scale charts
(B) High-water mark along the coast
(C) Boundary separating the EEZ and the High Seas
(D) Edge of the continental margin

2004

28. Select the correct order of maritime zones from the coast seaward under UNCLOS:
(A) Contiguous Zone, Territorial Sea, EEZ, High Seas
(B) Territorial Sea, EEZ, Contiguous Zone, High Seas
(C) Territorial Sea, Contiguous Zone, EEZ, High Seas
(D) EEZ, Territorial Sea, Contiguous Zone, High Seas

2014

29. The concept of "Maximum Sustainable Yield" (MSY) within the EEZ framework obliges coastal states to:
(A) Harvest the entire biomass annually
(B) Prohibit any foreign fishing regardless of surplus

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(C) Ignore scientific data in favor of economic growth
(D) Prevent over-exploitation through appropriate conservation measures

2017
30. Consider the following statements concerning the Indian Fisheries Act (1897):
I. It penalizes the use of explosives for catching fish.
II. It penalizes the use of poisons for catching fish.
III. It regulates deep-sea foreign fishing vessels.
IV. It grants states the power to make specific fisheries rules.
V. It was enacted post-independence.
Which of the above statement(s) is/are CORRECT?
(A) I, II, III and V
(B) II, III, IV and V
(C) I, II and IV
(D) I, II, IV and V

2018
31. State-level MFRAs typically delimit the territorial waters for mechanized fishing beyond a specific depth or distance to:
(A) Increase fuel subsidies
(B) Encourage foreign joint ventures
(C) Protect traditional non-mechanized fishers
(D) Eliminate all artisanal crafts

2024
32. The Letter of Permission (LOP) scheme in India's Deep Sea Fishing Policy was primarily intended to:
(A) Restrict Indian fishers to the territorial sea
(B) Ban the export of marine products
(C) Expand bottom trawling in shallow waters
(D) Facilitate the acquisition of resource-specific vessels

2021
33. Under the Environmental (Protection) Act (1986), coastal aquaculture units must primarily ensure their effluents do not:
(A) Exceed prescribed limits for suspended solids and nutrients
(B) Contain any freshwater
(C) Benefit local agricultural lands
(D) Enter the sea under any circumstances

2005
34. Match the taxa in List I with their primary legislative or international protective mechanism in List II:
List I: (Taxa)
P. Marine Turtles in India
Q. Endangered Cetaceans globally
R. Highly Migratory Fish Stocks
S. Threatened Corals in trade
List II: (Mechanism)
1. CITES Appendix listings
2. Wildlife (Protection) Act Schedule I
3. International Whaling Commission (IWC) regulations
4. UN Fish Stocks Agreement (UNFSA) frameworks
(A) P-1, Q-4, R-2, S-3
(B) P-2, Q-3, R-4, S-1
(C) P-3, Q-2, R-1, S-4
(D) P-4, Q-1, R-3, S-2

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2002
35. The Maritime Zones of India Act (1981) allows boarding of foreign vessels primarily to:
(A) Transfer crew to Indian vessels
(B) Ensure compliance with fishing licenses and regulations
(C) Confiscate navigational equipment arbitrarily
(D) Collect customs duties on transit goods

2004
36. Access and Benefit Sharing (ABS) under the Biological Diversity Act (2002) is designed to ensure equitable sharing of benefits arising from:
(A) Open access deep-sea fishing
(B) Maritime boundary delimitations
(C) The commercial utilization of biological resources
(D) The sale of modern fishing vessels

2023
37. Which Coastal Regulation Zone (CRZ) category specifically covers the water area from the Low Tide Line to 12 nautical miles seaward?
(A) CRZ-I
(B) CRZ-II
(C) CRZ-III
(D) CRZ-IV

2025
38. Consider the following statements of Assertion (A) and Reason (R) and select the correct answer:
Assertion (A): The National Policy on Marine Fisheries (2017) supports the integration of inland and marine fisheries frameworks.
Reason (R): The policy strictly prohibits all forms of mariculture in the Indian EEZ.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2008

39. The National Fisheries Development Board (NFDB) plays a pivotal role in:
(A) Providing subsidies and infrastructure for fisheries development
(B) Defining maritime boundaries
(C) Formulating global UN resolutions
(D) Regulating ship-source oil pollution

2001

40. Consider the following statements regarding Ecolabeling and MSC certification:
I. It guarantees zero impact on the marine environment.
II. It provides market-based incentives for sustainable fishing.
III. It relies on the principle of trace-back chain of custody.
Which of the above statement(s) is/are INCORRECT?
(A) II and III
(B) I only
(C) I and III
(D) I and II

2002

41. The EU Catch Certificate primarily functions to:
(A) Guarantee minimum wage for fishers
(B) Establish RFMO boundary coordinates
(C) Document that imported fish was caught in compliance with conservation laws
(D) Replace CITES permits for all species

2011

42. Under UNCLOS, compulsory dispute settlement mechanisms regarding high seas fisheries do NOT include:
(A) The International Tribunal for the Law of the Sea (ITLOS)
(B) The International Court of Justice (ICJ)
(C) Arbitral tribunals constituted under Annex VII
(D) Domestic state courts of the infringing vessel

2001

43. Quota allocations under the UNFSA for straddling stocks are typically implemented through:
(A) Regional Fisheries Management Organizations (RFMOs)
(B) Unilateral declarations by coastal states
(C) The United Nations General Assembly
(D) Non-governmental environmental organizations

2007

44. The Ecosystem Approach to Fisheries (EAF) as promoted by the FAO CCRF shifts management focus from:
(A) Coastal conservation to deep-sea mining
(B) Fisheries regulation to unmanaged aquaculture
(C) Single-species yield to broader ecosystem health
(D) Global governance to local deregulation

2017

45. Consider the following regulatory mechanisms:
I. State MFRA
II. United Nations Convention on the Law of the Sea (UNCLOS)
III. Indian Coastal Regulation Zone (CRZ) notification
IV. Regional Fisheries Management Organization (RFMO) measures
Which of the following represents the correct ascending order of their geographic scope (Local to Global)?
(A) III, I, IV, II
(B) I, III, II, IV
(C) III, I, II, IV
(D) I, IV, III, II

2007

46. Under CITES, Appendix II species are those that:
(A) Are not necessarily threatened with extinction, but trade must be controlled
(B) Are completely banned from international trade
(C) Are protected in at least one country which has asked for assistance
(D) Are exempt from all customs documentation

2007

47. A core instrument under the Convention on Migratory Species (CMS) for the conservation of aquatic species is the:
(A) Immediate ban on all commercial shipping
(B) Eradication of artificial reefs
(C) Development of regional Memorandums of Understanding (MoUs)
(D) Privatization of migratory routes

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2022

48. Consider the following stages in determining a Ramsar site:

I. Official designation and listing by the Ramsar Secretariat
II. Identification of a wetland meeting specific international criteria
III. Proposal submission by the national government
IV. Implementation of a wise-use management plan

What is the correct logical order of these stages?

(A) II, III, I, IV
(B) III, II, IV, I
(C) II, I, III, IV
(D) I, II, IV, III

2008

49. MARPOL Annex V significantly impacts fisheries by strictly prohibiting the discharge of:

(A) Biodegradable food waste
(B) All plastics, including synthetic ropes and fishing nets
(C) Fresh water ballast
(D) Cooling water from marine engines

2015

50. Consider the following statements concerning the International Whaling Commission (IWC):

I. It instituted a moratorium on commercial whaling.
II. It prohibits aboriginal subsistence whaling entirely.
III. It establishes whale sanctuaries.
IV. It sets commercial catch limits for marine turtles.

Which of the above statement(s) is/are CORRECT?

(A) I and III
(B) I, II and III
(C) I, III and IV
(D) II and IV

2010

51. Binding resolutions adopted by the Indian Ocean Tuna Commission (IOTC) obligate member states to:

(A) Ignore scientific committee advice
(B) Expand open-access fishing for demersal species
(C) Implement domestic catch limits and gear restrictions for tuna
(D) Withdraw from UNCLOS provisions

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2005

52. The BOBP-IGO enhances artisanal fisheries governance by focusing on:

(A) Issuing commercial deep-sea licenses to foreign fleets
(B) Delimiting continental shelf boundaries
(C) Enforcing the global ivory trade ban
(D) Safety at sea and community capacity building

2022

53. State regulatory intervention in fisheries is fundamentally justified to counteract:

(A) The economic inefficiencies and stock depletion of open access
(B) Efficient market allocation of resources
(C) The overabundance of target species
(D) Spontaneous adoption of sustainable practices by fishers

2022

54. The baseline from which the territorial sea is measured is most critical for:

(A) Determining inland freshwater fishing rights
(B) Establishing the inner limit of all maritime jurisdictional zones
(C) Regulating urban coastal development
(D) Setting aquaculture production targets

2023

55. Consider the following statements of Assertion (A) and Reason (R) and select the correct answer:

Assertion (A): The Exclusive Economic Zone (EEZ) grants coastal states absolute sovereignty identical to that of the territorial sea.

Reason (R): Within the EEZ, coastal states have sovereign rights strictly for the purpose of exploring and exploiting natural resources.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2008

56. The Indian Fisheries Act (1897) is historically significant because it was the first central legislation to:

(A) Establish the Exclusive Economic Zone
(B) Regulate aquaculture exports
(C) Mandate turtle excluder devices
(D) Prohibit destructive fishing practices like dynamiting and poisoning

2007
57. Zonation of territorial waters under MFRAs restricts mechanized vessels to deeper waters primarily to prevent:
(A) Conflict with traditional non-mechanized craft
(B) Navigation hazards for international shipping
(C) Coral reef bleaching
(D) Oil spills from trawlers

2017
58. Select the correct sequence of policy evolution in India's marine fisheries:
(A) Deep Sea Fishing Policy (1991) → Murari Committee → NPMF (2017)
(B) Murari Committee → NPMF (2017) → Deep Sea Fishing Policy (1991)
(C) NPMF (2017) → Murari Committee → Deep Sea Fishing Policy (1991)
(D) Deep Sea Fishing Policy (1991) → NPMF (2017) → Murari Committee

2009
59. Effluent regulations under the Environmental (Protection) Act (1986) require coastal aquaculture farms to monitor:
(A) Only salinity levels
(B) Suspended solids, BOD, and dissolved oxygen
(C) The color of the fish harvested
(D) Acoustic pollution levels

2015
60. Consider the following statements regarding Schedule I of the Wildlife (Protection) Act (1972):
I. It includes all commercially viable marine teleosts.
II. It includes the whale shark (Rhincodon typus).
III. It permits regulated commercial trade of listed species.
IV. It includes certain species of marine corals.
V. It prohibits hunting of listed species.
Which of the above statement(s) is/are INCORRECT?
(A) I, II and IV
(B) I and III
(C) I, III and V
(D) II, IV and V

2010
61. Enforcement of the Maritime Zones of India Act (1981) primarily falls under the jurisdiction of the:
(A) National Biodiversity Authority
(B) Marine Products Export Development Authority
(C) Fishery Survey of India
(D) Indian Coast Guard

2002
62. The Biological Diversity Act (2002) establishes State Biodiversity Boards primarily to:
(A) Advise state governments on conservation and regulate commercial use of bio-resources
(B) Issue licenses for foreign deep-sea fishing
(C) Regulate coastal shipping lanes
(D) Manage deep-sea mineral extraction

2014
63. Prohibited activities within CRZ-I generally include:
(A) Traditional artisanal fishing
(B) Manual collection of seaweeds
(C) Setting up new industries or expanding existing ones
(D) Scientific research with appropriate clearances

2022
64. Match the policy/legislation in List I with its core focus in List II:
List I: (Policy/Legislation)
P. NPMF (2017)
Q. MPEDA Act (1972)
R. CRZ Notification
S. MZI Act (1981)
List II: (Core Focus)
1. Seafood export quality and promotion
2. Coastal land use and zonation
3. Comprehensive marine fisheries strategy
4. Regulation of foreign fishing vessels
(A) P-3, Q-1, R-2, S-4
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-2, R-1, S-4
(D) P-2, Q-1, R-4, S-3

2018
65. The NFDB mandate includes capacity building and financial assistance primarily to:
(A) Decrease domestic fish consumption
(B) Increase fisheries production and productivity
(C) Establish international trade tariffs
(D) Enforce the UNCLOS treaty provisions

2008
66. Ecolabeling in fisheries provides a mechanism where:
(A) Governments unilaterally ban all seafood imports

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dioxide, eliminates the risk of high-GWP gas leakage, lowering the indirect carbon footprint of seafood processing.

295. (A) II, IV, I, III
Developing a rigorous climate adaptation plan in fisheries follows a logical, step-by-step sequence. First, managers conduct a vulnerability assessment to identify key climate hazards and risks. Next, they identify appropriate adaptation options, followed by implementing these targeted adaptation actions. Finally, they monitor and evaluate outcomes to refine and adjust strategies over time.

296. (B) Their vulnerability is high while historical emissions are relatively low
National Action Plans on Climate Change in developing nations often prioritize adaptation strategies over mitigation efforts. This focus is driven by equity and vulnerability. Developing states typically face severe climate impacts while having contributed minimally to historical global greenhouse gas emissions. Adaptation is essential to protect vulnerable populations and secure domestic food production.

297. (C) Scenarios of radiative forcing trajectories up to the year 2100
Representative Concentration Pathways are standardized future scenarios utilized in IPCC climate modeling. These pathways describe alternative trajectories of radiative forcing, measured in watts per square meter, up to the year twenty-one hundred. They provide models with consistent inputs of greenhouse gas concentration pathways to project future global warming, precipitation, and sea-level rise.

298. (D) Organic carbon to inorganic carbon (calcium carbonate)
The efficiency of the biological carbon pump is heavily influenced by the rain ratio. This term refers to the relative export ratio of organic carbon, produced by soft-tissue primary producers, to inorganic carbon, representing the sinking calcium carbonate shells of calcifiers. A higher rain ratio enhances the ocean's capacity to sequester atmospheric carbon dioxide.

299. (A) El Niño-Southern Oscillation
The atmospheric Walker Circulation is a major zonal circulation cell spanning the equatorial Pacific Ocean. Under normal conditions, strong trade winds drive warm water westward. Disruption or weakening of this circulation directly governs the onset and intensity of the El Niño-Southern Oscillation, driving widespread anomalies in global temperatures, precipitation, and marine upwelling.

300. (B) Productivity, resilience, and mitigation
Climate-smart fisheries management is a comprehensive framework designed to address climate impacts. It integrates three core objectives: sustainably increasing fisheries productivity and coastal incomes, adapting and building the resilience of marine ecosystems and human communities, and mitigating climate change by reducing the greenhouse gas emission intensity of harvesting and post-harvest operations.

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(B) Unilateral demands by the most powerful state
(C) Historical catches, scientific advice, and coastal state rights
(D) Random lottery draws

2015
77. The BOBP-IGO primarily targets capacity building in which sector?
(A) Deep-sea mining
(B) High-seas pelagic whaling
(C) Freshwater ornamental aquaculture
(D) Artisanal and small-scale coastal fisheries

2006
78. In fisheries economics, the concept of "Open Access" leads to rent dissipation because:
(A) New entrants continue fishing as long as average revenue exceeds average cost
(B) Fishing effort is restricted to the most efficient vessels
(C) Property rights are well-defined and enforceable
(D) Catch limits are strictly observed by all users

2023
79. The baseline definition is crucial for maritime boundaries because it:
(A) Identifies the maximum depth for bottom trawling
(B) Serves as the starting point for measuring the Territorial Sea, Contiguous Zone, and EEZ
(C) Determines the salinity levels of coastal waters
(D) Marks the boundary of inland lakes

2010
80. Consider the following statements concerning the Continental Shelf under UNCLOS:
I. It comprises the seabed and subsoil of the submarine areas extending beyond the territorial sea.
II. The coastal state has sovereign rights for exploring and exploiting its natural resources.
III. It includes the water column above the seabed beyond the EEZ.
IV. It can extend up to a maximum of 350 nautical miles under certain geological conditions.
Which of the above statement(s) is/are CORRECT?
(A) I and II
(B) II and IV
(C) I, II and IV
(D) III only

2024
81. Under the Indian Fisheries Act (1897), penalties for offenses typically involve:
(A) Execution
(B) Mandatory community service
(C) Revocation of citizenship
(D) Fines and potential imprisonment

2005
82. Which structural constraint is commonly enforced by MFRAs on mechanized fishing gear?
(A) Minimum mesh size regulations to prevent juvenile catch
(B) Mandatory use of sonar
(C) Compulsory painting of nets
(D) Prohibition of ice storage on board

2024
83. The 1991 Deep Sea Fishing Policy of India led to controversy primarily due to:
(A) The complete ban on all deep-sea fishing
(B) Conflicts between traditional fishers and joint venture foreign vessels
(C) Over-subsidization of artisanal crafts
(D) Enforcement of strict environmental laws

2022
84. The Environmental (Protection) Act (1986) empowers the central government to:
(A) Issue commercial fishing licenses
(B) Manage international whaling quotas
(C) Lay down standards for the quality of environment and emission/discharge of pollutants
(D) Negotiate the UNCLOS treaty

NODIA

2014
85. Consider the following taxa protected under the Wildlife (Protection) Act (1972):
I. Common edible marine teleosts
II. Certain marine sponges and corals
III. Whale Shark
What is the correct order of these taxa in terms of their increasing protection status (lowest to highest)?
(A) I, II, III
(B) III, II, I
(C) II, I, III
(D) I, III, II

2016
86. Boarding procedures under the MZI Act (1981) authorize designated officers to:

(A) Mass commercial consumption
(B) Private aquarium trade
(C) Scientific research or conservation breeding
(D) Subsistence food harvesting

2010

172. The CMS defines "range states" as:
(A) States whose flag vessels fish on the high seas
(B) States that exercise jurisdiction over any part of the range of a migratory species
(C) Landlocked states
(D) States that conduct commercial whaling

2010

173. The Ramsar concept of "wise use" of wetlands is equated with:
(A) Absolute preservation
(B) Complete drainage for agriculture
(C) Sustainable development
(D) Unrestricted urban expansion

2001

174. MARPOL Annex V requires ships to maintain a Garbage Record Book to track:
(A) Engine fuel consumption
(B) Crew payroll
(C) Catch statistics
(D) Discharges and disposals of garbage, including fishing gear

2021

175. The International Whaling Commission provides exemptions for aboriginal whaling to:
(A) Address cultural and nutritional needs of indigenous peoples based on scientific advice
(B) Maximize commercial market demand for whale products in major international markets
(C) Adhere to total allowable catch limits established for straddling fish stocks by RFMOs
(D) Follow open access principles for the unregulated harvest of all large whale species

2006

176. Which of the following is an active resolution by the IOTC concerning bycatch?
(A) Mandatory retention of all shark species
(B) Measures to reduce bycatch of sea turtles and seabirds in longline fisheries
(C) Banning all longline fishing in the Indian Ocean
(D) Subsidizing bycatch landings

2015

177. A core objective of the BOBP-IGO is to:
(A) Implement the UNCLOS treaty globally
(B) Enforce deep-sea commercial whaling limits
(C) Improve the socio-economic conditions of small-scale fisherfolk in the Bay of Bengal
(D) Regulate inland freshwater aquaculture

2002

178. Without state regulatory intervention, open access fisheries typically reach bionomic equilibrium where:
(A) Total revenue heavily exceeds total costs
(B) Total revenue equals total costs, dissipating resource rent
(C) Fish stocks expand exponentially
(D) Effort is reduced voluntarily

2006

179. If a coastline is deeply indented or fringed with islands, UNCLOS permits the use of:
(A) Normal baselines
(B) Continental shelf limits
(C) Straight baselines connecting appropriate points
(D) Archipelagic baselines for non-archipelagic states

2023

180. The 200 nm EEZ limit is measured exclusively from the:
(A) Edge of the continental shelf
(B) Territorial sea outer limit
(C) High-water mark
(D) Baseline

2017

181. Under the Indian Fisheries Act (1897), police officers may arrest without a warrant if:
(A) A person commits an offense under section 4 (explosives) or section 5 (poisons)
(B) A person is using a prohibited net in open sea
(C) A person exports fish without a license
(D) A person builds an aquaculture pond

2017

182. A primary feature of spatial zonation in state MFRAs is to:
(A) Allow large trawlers to fish immediately off the beach without any spatial restrictions
(B) Assign specific distances from the shore for different classes of fishing vessels
(C) Prohibit traditional fishing activities entirely to allow for industrial fleet expansion
(D) Increase fuel subsidies for mechanized boats

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lacking direct legal enforcement mechanisms.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2014
96. CITES regulates the international trade of threatened species through a system of:
(A) Quotas determined solely by the importing country
(B) Voluntary eco-labels on retail products
(C) Total bans on all aquatic species
(D) Export and import permits governed by Appendices I, II, and III

2012
97. The CMS (Bonn Convention) defines a "migratory species" as one whose members cyclically and predictably:
(A) Cross one or more national jurisdictional boundaries
(B) Change depth within the same coastal reef
(C) Move between fresh and salt water within one country
(D) Alter their diet according to the season

2017
98. Consider the following statements of Assertion (A) and Reason (R) and select the correct answer:
Assertion (A): Ramsar site designation requires the outright prohibition of all human activity within the wetland.
Reason (R): The Ramsar Convention promotes the "wise-use" principle, allowing sustainable utilization of wetland resources.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2012
99. The prohibition of plastic disposal under MARPOL Annex V is particularly targeted at mitigating which impact on marine life?
(A) Coral bleaching
(B) Ingestion and entanglement
(C) Salinity alterations
(D) Acoustic interference

2008
100. Catch limits under the IWC for commercial whaling have effectively been set to what value since the 1986 moratorium?
(A) 1000 per member state
(B) 10% of the standing stock
(C) Zero
(D) Maximum Sustainable Yield

2019
101. Which species group falls strictly under the mandate of the Indian Ocean Tuna Commission (IOTC)?
(A) Demersal finfish in the Indian Ocean
(B) Marine mammals in the Southern Ocean
(C) Freshwater carps in South Asia
(D) Tuna and tuna-like species in the Indian Ocean

NODIA

2001
102. The BOBP-IGO operates in which regional context?
(A) The Bay of Bengal region
(B) The Mediterranean Sea
(C) The Caribbean Sea
(D) The Baltic Sea

2008
103. The rationale for state regulatory intervention in fisheries is best SUPPORTED by which economic concept?
(A) Marginal cost equating to marginal revenue of the fleet
(B) Externalities where individual actions negatively impact the collective resource
(C) Perfect competition ensuring biological sustainability
(D) Zero transaction costs in forming private agreements

2006
104. For archipelagic states, baselines are uniquely drawn by connecting:
(A) The deepest points of the ocean floor
(B) The capitals of the respective islands
(C) The outermost points of the outermost islands and drying reefs
(D) Points exactly 200 nm from the geographic center

2023
105. Match the maritime zone in List I with its corresponding nautical mile limit from the baseline in List II:
List I: (Maritime Zone)
P. Territorial Sea

2002

125. The International Whaling Commission calculates sustainable limits using the:
(A) Maximum Economic Yield formula
(B) Revised Management Procedure (RMP)
(C) Open Access Dynamic Model
(D) Unrestricted Catch Quota

2017

126. Data reporting requirements under the IOTC mandate member states to provide:
(A) Only economic profit data
(B) Vessel fuel consumption records exclusively
(C) Total catch, effort data, and size frequency data of tuna catches
(D) The nationality of the consumers

2004

127. Which United Nations Sustainable Development Goal (SDG) specifically deals with 'Life Below Water'?
(A) SDG 12
(B) SDG 13
(C) SDG 14
(D) SDG 15

2003

128. Consider the following statements of Assertion (A) and Reason (R) and select the correct answer:
Assertion (A): Overcapitalization in fisheries occurs because open access leads to excessive investment in fishing effort.
Reason (R): In open access, individual fishers ignore the external costs their effort imposes on the stock and on other fishers.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2022

129. The Contiguous Zone allows a coastal state to exercise control necessary to prevent and punish infringements of its:
(A) Deep-sea mining regulations
(B) Customs, fiscal, immigration, or sanitary laws
(C) High seas fishing quotas
(D) Space exploration policies

2010

130. Sovereign rights in the EEZ specifically do NOT include:
(A) Exploration of natural resources
(B) Jurisdiction over marine scientific research
(C) Absolute sovereignty over the airspace above the EEZ for restricting foreign commercial flights
(D) Conservation and management of living resources

2010

131. Which of the following is an offense punishable under the Indian Fisheries Act (1897)?
(A) Using a traditional cast net
(B) Selling fish at a local market
(C) Operating an aquaculture pond
(D) Discharging dynamite to catch fish in navigable rivers

2004

132. MFRAs empower state governments to regulate gear specifically by:
(A) Imposing minimum mesh size limits for trawl cod ends
(B) Banning the use of all nets
(C) Enforcing maximum vessel color requirements
(D) Determining fuel subsidies

2009

133. The transition from the 1991 Deep Sea Policy to the Murari Committee recommendations marked a shift towards:
(A) Unregulated foreign joint ventures
(B) Safeguarding the interests of the domestic fishing industry and traditional fishers
(C) Completely banning deep-sea fishing
(D) Expanding bottom trawling into the high seas

2002

134. Coastal pollution controlled under the Environmental (Protection) Act (1986) specifically includes limits on the discharge of heavy metals because they:
(A) Increase water buoyancy
(B) Bioaccumulate in aquatic food webs
(C) Enhance coral growth
(D) Decrease navigational hazards

2022

135. Sea cucumbers are protected in India under which Schedule of the Wildlife (Protection) Act (1972)?
(A) Schedule V
(B) Schedule IV
(C) Schedule II
(D) Schedule I

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2009

115. Subsidies provided by the MPEDA are typically aimed at:
(A) Encouraging juvenile fish harvesting
(B) Expanding the size of traditional wooden canoes
(C) Upgrading processing facilities to meet international hygiene standards
(D) Purchasing marine mammal products

2021

116. Chain of Custody certification in ecolabeling guarantees that:
(A) Uncertified products are mixed with certified ones
(B) The retail price is artificially fixed
(C) The fishery does not require scientific stock assessment
(D) The product is kept separate and traceable back to the certified fishery

2021

117. The primary enforcement mechanism of the Port State Measures Agreement (PSMA) is:
(A) Denying port entry or use of port services to known IUU vessels
(B) Arresting the flag state's ambassador
(C) Sinking IUU vessels immediately upon entry
(D) Confiscating all cargo without inspection

2002

118. Under UNCLOS, marine scientific research within the EEZ by a foreign state requires:
(A) No notification or consent
(B) Only a notification to the UN Secretary-General
(C) The prior consent of the coastal state
(D) Payment of a mandatory global tax

2025

119. Conservation measures under UNFSA require that states adopt the precautionary approach, which implies that:
(A) Lack of full scientific certainty shall not be used as a reason for postponing conservation measures
(B) No conservation measures can be taken without absolute scientific proof
(C) Fishing must cease completely until stocks double
(D) Economic interests override environmental concerns

2025

120. Article 11 of the FAO CCRF provides specific guidelines for the responsible development of:
(A) High-seas bottom trawling
(B) Deep-sea oil drilling
(C) Aquaculture and culture-based fisheries
(D) Commercial whaling

2011

121. To issue an export permit for an Appendix II species under CITES, the Scientific Authority of the exporting state must advise that:
(A) The species is bred entirely in captivity
(B) The export will maximize commercial revenue
(C) The species is locally extinct
(D) Such export will not be detrimental to the survival of the species

2009

122. Under the CMS, species listed in Appendix I are defined as:
(A) Endangered migratory species subject to strict protection
(B) Migratory species requiring international MoUs
(C) Species that are globally abundant
(D) Commercially viable species suitable for open trade

2018

123. The Montreux Record under the Ramsar Convention lists wetland sites where:
(A) No human activity has ever occurred
(B) Changes in ecological character have occurred, are occurring, or are likely to occur
(C) Only marine teleosts are found
(D) Urban development is fully sanctioned

NODIA

2006

124. Match the convention in List I with its corresponding key instrument or annex in List II:
List I: (Convention)
P. MARPOL
Q. Ramsar
R. CITES
S. UNCLOS
List II: (Instrument/Annex)
1. Annex V (Garbage)
2. Appendices I, II, III
3. Montreux Record
4. Annex VII (Arbitration)
(A) P-1, Q-3, R-2, S-4
(B) P-3, Q-1, R-4, S-2
(C) P-2, Q-4, R-1, S-3
(D) P-1, Q-2, R-3, S-4

Q. Contiguous Zone
R. Exclusive Economic Zone
S. Continental Shelf (General minimum limit)
List II: (Limit)
1. 12 nm
2. 24 nm
3. 200 nm
4. 200 nm (or outer edge of continental margin)
(A) P-1, Q-2, R-3, S-4
(B) P-1, Q-3, R-4, S-2
(C) P-4, Q-1, R-2, S-3
(D) P-2, Q-1, R-4, S-3

2005

106. The Indian Fisheries Act (1897) defines 'water' to include:
(A) Only the high seas
(B) The sea within one marine league of the sea coast and navigable rivers
(C) Only artificial aquaculture ponds
(D) International shipping lanes

2011

107. Which action constitutes a violation of the monsoon trawl ban enforced by MFRAs?
(A) Operating traditional non-mechanized catamarans for fishing during the monsoon period
(B) Harvesting freshwater fish from designated inland aquaculture ponds for local markets
(C) Operating mechanized bottom trawlers in territorial waters during the closed season
(D) Exporting previously frozen seafood products processed before the monsoon season began

2006

108. Guidelines for Letter of Permission (LOP) vessels under India's deep-sea policies mandated that:
(A) The entire catch must be discarded at sea
(B) Vessels must exclusively fish in the territorial sea
(C) No positional tracking devices could be installed
(D) Foreign crew must eventually be replaced by Indian crew

2021

109. Discharge standards under the Environmental (Protection) Act (1986) are enforced at the state level by:
(A) State Pollution Control Boards
(B) The Indian Coast Guard
(C) The Ministry of Earth Sciences
(D) The Fishery Survey of India

2008

110. Which coral formation is explicitly protected under Schedule I of the Wildlife (Protection) Act (1972)?
(A) All artificial reefs
(B) Reef-building corals, black corals, and fire corals
(C) Fossilized coral limestone
(D) Coral sand

2007

111. The MZI Act (1981) specifies that confiscated foreign vessels and catches:
(A) Must be returned immediately with a warning
(B) Can be claimed by the capturing Coast Guard officer
(C) Are liable to be forfeited to the Central Government
(D) Must be sunk in deep water

2019

112. Under the Biological Diversity Act (2002), Indian citizens accessing biological resources for commercial utilization must give prior intimation to the:
(A) National Biodiversity Authority
(B) Ministry of Environment, Forest and Climate Change
(C) United Nations
(D) State Biodiversity Board

2008

113. CRZ-IV includes the water area from the Low Tide Line up to 12 nautical miles. What is the primary management focus in this zone?
(A) Regulating municipal waste discharge and pollution
(B) Constructing large-scale residential complexes on the water
(C) Promoting unrestricted sand mining
(D) Prohibiting all forms of navigation

2001

114. The NPMF (2017) addresses gender equity in fisheries by emphasizing:
(A) The exclusion of women from the supply chain
(B) The empowerment of women in post-harvest processing and marketing
(C) Mandating female-only crews on deep-sea vessels
(D) Banning women from participating in mariculture

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2002

136. The penalty for unauthorized foreign fishing under the MZI Act (1981) can include:
(A) Confiscation of the vessel, gear, and catch, along with substantial fines
(B) Deportation without any monetary fine
(C) A formal written apology
(D) Integration into the Indian fleet

2012

137. Which body grants approval for intellectual property rights based on research on biological resources obtained from India?
(A) State Biodiversity Boards
(B) National Biodiversity Authority
(C) Ministry of Commerce
(D) Indian Council of Agricultural Research

2008

138. Which activity is generally permitted in CRZ-III areas?
(A) Setting up new hazardous waste treatment plants
(B) Construction of large commercial malls
(C) Agriculture and traditional fishing-related activities
(D) Discharge of untreated municipal sewage

2010

139. The NPMF (2017) aims to replace open access in marine fisheries with a system of:
(A) Total privatization of the territorial sea
(B) Absolute bans on mechanized fishing
(C) Unrestricted international fleet access
(D) Managed access and regulated entry

2015

140. Which authority is responsible for registering seafood processing units for export from India?
(A) MPEDA
(B) Indian Coast Guard
(C) National Biodiversity Authority
(D) Ministry of Defence

2008

141. The Marine Stewardship Council (MSC) ecolabel applies specifically to:
(A) Wild-capture fisheries
(B) Aquaculture products
(C) Processed agricultural products
(D) Deep-sea minerals

2010

142. The IUU vessel list maintained by RFMOs serves primarily to:
(A) Award government subsidies
(B) Assign maximum allowable catches
(C) Identify and penalize vessels engaged in illicit fishing activities
(D) Promote open access on the high seas

2005

143. Which UNCLOS body handles disputes concerning the interpretation of the convention regarding marine resources?
(A) World Trade Organization
(B) International Whaling Commission
(C) Food and Agriculture Organization
(D) International Tribunal for the Law of the Sea (ITLOS)

2018

144. The UNFSA requires RFMO members to adopt conservation measures based on:
(A) The best scientific evidence available
(B) Economic profitability of the fleets
(C) Political lobbying by member states
(D) The size of the member state's navy

2017

145. The Ecosystem Approach to Fisheries (EAF) explicitly incorporates which factor not traditionally used in single-species management?
(A) Total catch weight exclusively
(B) Vessel engine horsepower
(C) Bycatch, habitat impacts, and trophic interactions
(D) Fuel prices

2002

146. Which document must accompany any commercial shipment of a CITES Appendix II species?
(A) An export permit from the country of origin
(B) An import permit from the destination country
(C) A Catch Certificate from the EU
(D) A written authorization from the UN Secretary-General

2005

147. Under the CMS, an MoU for marine mammals aims to facilitate:
(A) Unregulated bycatch limits
(B) Commercial harvesting
(C) Coordinated research, conservation, and mitigation of anthropogenic threats
(D) Captive breeding for global aquariums

2012

148. A wetland is considered internationally important under Ramsar criteria if it regularly

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supports what percentage of a population of a waterbird species?
(A) 0.1%
(B) 1%
(C) 10%
(D) 50%

2017
149. The primary objective of MARPOL Annex V regulations on fishing gear is to prevent:
(A) Navigational hazards to large container ships
(B) The smuggling of contraband
(C) Marine plastic pollution and ghost fishing
(D) The spread of invasive species

2011
150. Which species falls strictly under the regulatory purview of the International Whaling Commission?
(A) Basking shark
(B) Whale shark
(C) Manta ray
(D) Blue whale

2013
151. Catch allocations by the IOTC are designed to:
(A) Distribute the total allowable catch among members sustainably
(B) Maximize catches for distant water fishing nations only
(C) Encourage IUU fishing
(D) Eliminate all fishing of yellowfin tuna

2022
152. The Bay of Bengal Programme (BOBP-IGO) primarily functions as a:
(A) Treaty-making body for boundary delimitation
(B) Law enforcement agency
(C) Regional advisory and capacity-building organization
(D) Global certification board

2018
153. A central premise of state intervention in fisheries is that fish stocks are:
(A) Inexhaustible resources
(B) Common-pool resources subject to subtractability
(C) Public goods with no rivalry in consumption
(D) Exclusively private property

2002
154. Normal baselines under UNCLOS are typically drawn at the:
(A) High water mark
(B) Mean sea level
(C) Low water line along the coast
(D) 200-meter isobath

NODIA

2005
155. If the continental margin extends beyond 200 nm, UNCLOS allows coastal states to claim continental shelf rights up to:
(A) 500 nm from the baseline
(B) The mid-ocean ridge
(C) The baseline of the opposite state
(D) 350 nm from the baseline

2002
156. The Indian Fisheries Act (1897) prohibits the use of poisons to:
(A) Catch or destroy fish intentionally
(B) Preserve fish post-harvest
(C) Eradicate invasive species officially
(D) Clean aquaculture ponds

2009
157. State MFRAs mandate the registration of mechanized vessels to:
(A) Facilitate unregulated fleet expansion
(B) Ensure safety, regulate fishing effort, and monitor catches
(C) Grant them open access to foreign EEZs
(D) Eliminate traditional fishing vessels

2016
158. The Murari Committee (1995) explicitly recommended the cancellation of which scheme in India's deep-sea sector?
(A) Artisanal vessel subsidies
(B) Inland aquaculture schemes
(C) Joint ventures and chartering of foreign deep-sea fishing vessels
(D) Marine scientific research permits

2011
159. The Environmental (Protection) Act (1986) empowers the central government to restrict industrial operations in coastal zones to protect:
(A) International shipping lanes
(B) Deep-sea mining sites
(C) High seas fisheries
(D) Ecologically sensitive areas and marine biodiversity

2012
160. Which of the following marine reptiles is protected under Schedule I of the Wildlife (Protection) Act (1972)?
(A) Olive Ridley sea turtle
(B) Sea snakes

(C) Marine iguanas
(D) Freshwater terrapins

2002

161. A foreign vessel permitted to fish in the Indian EEZ under the MZI Act (1981) must strictly adhere to:
(A) Adhere strictly to the maritime laws of its home flag state throughout its operations
(B) Adhere to license conditions regarding specified fishing zones, gear, and catch quotas
(C) Comply with United Nations regulations which override Indian sovereign maritime laws
(D) Conduct unregulated transshipment of catch at sea to various international transport ships

2025

162. The Biological Diversity Act (2002) mandates the establishment of Biodiversity Management Committees (BMCs) at which level?
(A) National
(B) State
(C) Local self-government (Panchayat/ Municipality)
(D) International

2007

163. Which Coastal Regulation Zone (CRZ) category specifically covers built-up infrastructure areas?
(A) Protecting ecologically sensitive areas such as mangroves and coral reef systems
(B) Maintaining coastal regions that are completely untouched by any human activity
(C) Designating coastal lands exclusively for the development of commercial aquaculture
(D) Managing areas substantially built-up with infrastructure close to the shoreline

2015

164. The NPMF (2017) recommends spatial and temporal closures primarily to:
(A) Protect spawning stocks and juvenile fish
(B) Reduce coastal navigation
(C) Facilitate offshore oil drilling
(D) Decrease the market supply of fish

2003

165. Financial assistance from the NFDB is intended for which specific post-harvest activity?
(A) Building international container ships
(B) Establishing cold storage and fish markets
(C) Purchasing explosives for fishing
(D) Subsidizing foreign fishing fleets

2022

166. MSC certification requires that a fishery must not conduct operations using:
(A) Traditional hook and line
(B) Sonar equipment
(C) Destructive fishing practices like poisons or explosives
(D) Mechanized vessels

2006

167. Port State Measures (PSM) are considered highly effective against IUU fishing because they:
(A) Authorize military forces to shoot down suspected illegal aircraft in international airspace
(B) Deny IUU vessels access to lucrative global markets and services through port restrictions
(C) Permanently replace national coast guard duties with international port authority management
(D) Implement systems to subsidize legitimate fishing vessels for increased commercial harvest

2011

168. Under UNCLOS, who holds jurisdiction over a vessel on the high seas?
(A) The flag state under whose registry the vessel operates
(B) The nearest coastal state
(C) The UN Security Council
(D) The ITLOS tribunal

2005

169. The UNFSA requires compatibility of conservation and management measures between:
(A) Inland waters and territorial seas
(B) Different continents
(C) The EEZ and the adjacent high seas for straddling stocks
(D) Marine and freshwater systems

2024

170. Article 11 of the FAO CCRF addresses post-harvest practices and trade, emphasizing:
(A) Food safety, quality, and minimizing post-harvest losses
(B) Decreasing nutritional value for profit
(C) Maximizing waste and discards
(D) Prohibiting all international fish trade

2024

171. A species listed in CITES Appendix I can only be traded internationally under exceptional circumstances, such as:

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(A) Sink foreign vessels on sight
(B) Examine logs, fishing gear, and catch of suspected foreign vessels
(C) Alter the maritime boundaries dynamically
(D) Confiscate personal belongings of the crew for personal use

2024

87. Under the Biological Diversity Act (2002), foreign individuals or entities seeking access to Indian biological resources must obtain prior approval from the:
(A) State Biodiversity Board
(B) Local Panchayat
(C) National Biodiversity Authority
(D) Ministry of Commerce

2015

88. CRZ-III areas are defined in the CRZ notifications as:
(A) Ecologically sensitive areas like mangroves
(B) Substantially built-up urban areas
(C) The water area from LTL to 12 nautical miles
(D) Relatively undisturbed areas that do not fall under CRZ-I or II, typically rural

2004

89. The NPMF 2017 advocates for the "blue growth" approach, which integrates:
(A) Sustainable economic growth with environmental conservation
(B) Total industrialization of the coastline
(C) Banning all marine capture fisheries
(D) Depletion of resources for short-term revenue

2013

90. Consider the following statements regarding the Marine Products Export Development Authority (MPEDA):
I. It promotes the export of all marine products from India.
II. It sets quality control standards for seafood exports.
III. It regulates foreign military vessels in the EEZ.
IV. It operates under the Ministry of Commerce and Industry.
V. It was established in 1972.
Which of the above statement(s) is/are CORRECT?
(A) I, II, IV and V
(B) I, III, IV and V
(C) II, III, IV and V
(D) I, II, III and V

2023

91. MSC green certification relies on three core principles: sustainability of the target stock, effective fisheries management, and:
(A) Maximizing corporate profits
(B) Maintaining low retail prices
(C) Minimizing environmental impact on the ecosystem
(D) Eliminating small-scale fisheries

2023

92. Catch documentation schemes are crucial for combating IUU fishing because they:
(A) Automatically increase the market price of fish
(B) Reduce the need for scientific stock assessments
(C) Subsidize fuel costs for compliant vessels
(D) Ensure traceability of catch from the point of harvest to the final market

2011

93. Freedom of navigation and overflight under UNCLOS applies to which maritime zones?
(A) The EEZ and the High Seas
(B) Internal waters and Territorial Sea only
(C) Territorial Sea only
(D) The Contiguous Zone only

NODIA

2010

94. Match the UN agreement/convention in List I with its primary objective in List II:
List I: (Agreement/Convention)
P. UNFSA
Q. PSMA
R. UNCLOS
S. MARPOL
List II: (Primary Objective)
1. Comprehensive legal framework for the oceans
2. Management of highly migratory species
3. Prevention of pollution from ships
4. Denying port access to IUU vessels
(A) P-2, Q-4, R-1, S-3
(B) P-1, Q-3, R-4, S-2
(C) P-4, Q-2, R-3, S-1
(D) P-2, Q-1, R-4, S-3

2022

95. Consider the following statements of Assertion (A) and Reason (R) and select the correct answer:
Assertion (A): The FAO CCRF strictly enforces legal penalties on states that fail to adopt sustainable aquaculture practices.
Reason (R): The CCRF is a voluntary instrument

operating within the exclusive economic zone

2010
183. The Letter of Permission (LOP) scheme for deep-sea fishing was criticized primarily for:
(A) Enforcing excessively high technological and safety standards for all domestic vessels
(B) Banning the export of deep-sea catch to protect domestic food security requirements
(C) Allowing foreign vessels to fish without adequate local benefit or regulatory control
(D) Over-regulating artisanal fishers by restricting their access to shallow coastal waters

2002
184. The Environmental (Protection) Act (1986) uses which mechanism to enforce compliance in coastal zones?
(A) Issuing MSC ecolabels
(B) Determining maximum sustainable yield
(C) Fixing domestic fish prices
(D) Coastal Regulation Zone (CRZ) Notifications

2004
185. The inclusion of all sawfishes (Pristidae) in Schedule I of the WPA (1972) reflects their status as:
(A) Critically threatened marine elasmobranchs
(B) Commercially viable targeted species
(C) Highly abundant marine species
(D) Invasive species

2014
186. The MZI Act (1981) distinguishes between foreign fishing vessels and:
(A) Foreign commercial aircraft
(B) Indian fishing vessels
(C) Domestic passenger ferries
(D) International cruise ships

2018
187. The People's Biodiversity Register (PBR) under the Biological Diversity Act (2002) is compiled to:
(A) Register foreign deep-sea vessels
(B) Issue fishing licenses
(C) Document traditional knowledge and local biological resources
(D) Track marine pollution

2006
188. Activities prohibited across all CRZ categories generally include:
(A) Traditional artisanal fishing
(B) Manual collection of shells
(C) Navigation of small boats
(D) Setting up new industries and disposal of hazardous substances

2024
189. The NPMF (2017) strongly advocates for the modernization of the fishing fleet to:
(A) Exploit deep-sea and oceanic resources sustainably
(B) Fish in shallow territorial waters
(C) Compete with artisanal fishers
(D) Harvest coral reefs

2010
190. Under the MPEDA Act, the Authority holds the power to inspect:
(A) Foreign vessels in the high seas
(B) Marine products intended for export and the premises where they are processed
(C) Inland freshwater dams
(D) Agricultural exports

2010
191. Ecolabeling schemes like MSC evaluate fisheries against standards established by:
(A) The World Trade Organization
(B) Local fishermen's unions unilaterally
(C) The FAO Code of Conduct for Responsible Fisheries guidelines
(D) The Indian Coast Guard

2017
192. The EU IUU Regulation prevents IUU seafood from entering the EU market by mandating:
(A) A certificate of origin from the importing state
(B) A visual inspection of all fish at retail stores
(C) An absolute ban on all wild-caught fish
(D) A standardized catch certificate validated by the flag state

2004
193. The right of innocent passage under UNCLOS applies within the:
(A) Territorial Sea
(B) Internal waters only
(C) High Seas
(D) Exclusive Economic Zone only

2013
194. UNFSA emphasizes the need for states to apply the precautionary approach, particularly when:
(A) Data are adequate and robust
(B) Fishing effort is zero
(C) Stock information is uncertain, unreliable, or

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inadequate
(D) Aquaculture production decreases

2017
195. Article 12 of the FAO CCRF deals with fisheries research, highlighting the need for:
(A) Sound scientific basis and data collection for conservation and management
(B) Research to exclusively support maximum exploitation
(C) Eliminating traditional ecological knowledge
(D) Privatizing all marine scientific data

2025
196. The transfer of a species from CITES Appendix II to Appendix I requires:
(A) Unilateral decision by the exporting state
(B) Approval from the World Trade Organization
(C) Scientific evidence showing the species is now threatened with extinction
(D) Complete extinction of the species

2003
197. The CMS specifically addresses anthropogenic threats to marine migratory species, such as:
(A) Natural predation
(B) Ocean noise, bycatch, and marine debris
(C) Lunar tidal cycles
(D) Oceanic salinity changes

2005
198. The Ramsar Convention's Secretariat is hosted by which organization?
(A) FAO
(B) UNEP
(C) IUCN
(D) WWF

2015
199. To comply with MARPOL Annex V, port states must provide:
(A) Free fuel to fishing vessels
(B) Catch documentation schemes
(C) Subsidized fishing gear
(D) Adequate reception facilities for garbage from ships

2001
200. The primary scientific body of the International Whaling Commission is responsible for:
(A) Advising on the status of whale stocks and catch limits
(B) Marketing whale meat
(C) Polling public opinion on whaling
(D) Building whaling ships

NODIA

2010
201. Compliance with IOTC resolutions by member states is monitored through:
(A) Unannounced military action
(B) Submission of national reports and compliance committee reviews
(C) The UN Security Council
(D) Citizen science platforms

2002
202. The BOBP-IGO achieves its capacity-building goals primarily through:
(A) Issuing monetary fines
(B) Arresting IUU vessels
(C) Regional workshops, training programs, and policy harmonization
(D) Granting MSC certifications

2004
203. Which state intervention explicitly addresses the Tragedy of the Commons by assigning access rights?
(A) Open registry flags
(B) Abolition of MFRAs
(C) Free fishing subsidies
(D) Individual Transferable Quotas (ITQs)

2007
204. Waters on the landward side of the baseline of the territorial sea form part of the state's:
(A) Internal Waters
(B) Contiguous Zone
(C) Exclusive Economic Zone
(D) High Seas

2010
205. Coastal states possess sovereign rights over the continental shelf primarily for the purpose of exploring and exploiting:
(A) Pelagic fish stocks
(B) Mineral and non-living resources, plus sedentary living organisms
(C) Wind energy exclusively
(D) Submarine communication cables

2002
206. The Indian Fisheries Act (1897) empowers state governments to frame rules to prohibit fishing in specified waters for a period not exceeding:
(A) 1 year
(B) 2 years
(C) 5 years
(D) 10 years

2004
207. Mechanized trawlers are often restricted from operating in shallow coastal areas primarily to:

(A) Protect deep-sea coral reefs located in international waters beyond the contiguous zone
(B) Prevent navigational hazards and collisions with large international cargo and container ships
(C) Safeguard small-scale traditional fishers and protect shallow coastal nursery grounds
(D) Decrease the total national fish catch to meet international environmental treaty obligations

2024
208. The LOP guidelines required deep-sea fishing vessels to be equipped with which monitoring technology?
(A) Submarine periscopes
(B) Handheld compasses only
(C) Analog radar
(D) AIS and VMS (Vessel Monitoring Systems)

2009
209. Under the Environmental (Protection) Act (1986), the discharge of untreated aquaculture wastewater into coastal waters is:
(A) Strictly regulated and penalized if standards are breached
(B) Encouraged for nutrient cycling
(C) Legally permissible
(D) Handled by the local panchayat unconditionally

2010
210. Which of the following elasmobranchs is explicitly listed under Schedule I of the Wildlife (Protection) Act (1972)?
(A) Spadenose shark
(B) Pondicherry shark (Carcharhinus hemiodon)
(C) Milk shark
(D) Silky shark

2019
211. Which document is mandatory for a foreign vessel to conduct fishing operations in the Indian EEZ under the MZI Act (1981)?
(A) A diplomatic passport
(B) A clearance from the WTO
(C) A valid license or permit issued by the Central Government
(D) A UNCLOS charter

2007
212. The Biological Diversity Act (2002) exemptions apply to:
(A) Foreign pharmaceutical companies
(B) Large-scale export firms
(C) Commercial deep-sea fishing fleets
(D) Local communities and vaids/hakims using bio-resources for traditional practices

2007
213. Aquaculture in CRZ areas is strictly regulated, generally permitting only:
(A) Traditional and improved traditional systems in specific zones with approvals
(B) Intensive mechanized farming in CRZ-I
(C) Unlimited use of groundwater
(D) Discharge of untreated effluents into estuaries

2014
214. The NPMF (2017) aligns national fisheries governance with the overarching international framework provided by:
(A) The Geneva Convention
(B) UNCLOS and the FAO CCRF
(C) The Paris Agreement solely
(D) The Kyoto Protocol

2002
215. The NFDB operates under the administrative control of the:
(A) Ministry of Commerce and Industry
(B) Ministry of Environment, Forest and Climate Change
(C) Ministry of Fisheries, Animal Husbandry and Dairying
(D) Ministry of Earth Sciences

2007
216. The MSC standard Principle 2 evaluates a fishery's impact on the:
(A) Target stock biomass
(B) Economic profitability of the fleet
(C) Traceability in the supply chain
(D) Marine ecosystem structure, productivity, function, and diversity

2011
217. Under the PSMA, if a port state has clear evidence that a vessel has engaged in IUU fishing, it must:
(A) Refuse port entry or prohibit landing, transshipping, and processing of fish
(B) Issue a small fine and allow landing
(C) Buy the catch at half price
(D) Arrest the crew immediately without flag state notification

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2022
289. The NPMF (2017) emphasizes the implementation of MCS to ensure compliance. What does MCS stand for?
(A) Marine Conservation Society
(B) Monitoring, Control, and Surveillance
(C) Minimum Catch Standards
(D) Maximum Commercial Subsidy

2018
290. The MPEDA is authorized to fix standards and specifications for marine products for the purpose of:
(A) Restricting domestic consumption
(B) Ensuring quality for international export markets
(C) Decreasing fisher incomes
(D) Subsidizing foreign imports

2005
291. How is MSC chain of custody certification maintained within the global supply chain?
(A) Mixed with various uncertified seafood batches throughout the global supply chain
(B) Accurately tracked and segregated from uncertified products at every processing stage
(C) Processed using destructive harvesting methods that have not been formally evaluated
(D) Sold exclusively at fixed government price points to regulate international seafood trade

2013
292. The EU Fish Catch Certificate must be validated by the competent authority of the:
(A) Importing EU member state
(B) Flag state of the catching vessel
(C) Retail supermarket
(D) Processing plant only

2010
293. Article 64 of UNCLOS specifically addresses the conservation and management of:
(A) Sedentary species
(B) Highly migratory species
(C) Anadromous stocks
(D) Catadromous species

2004
294. The UNFSA introduces the concept of sub-regional or regional organizations (RFMOs) as the primary mechanism for:
(A) Distributing global aquaculture subsidies
(B) Managing straddling and highly migratory fish stocks
(C) Regulating deep seabed mining
(D) Governing inland river navigation

2003
295. The FAO CCRF promotes the integration of fisheries into:
(A) Global weapons treaties
(B) Coastal area management programs
(C) Space exploration agendas
(D) Desertification initiatives

2011
296. Any species listed in CITES Appendix I can be traded internationally only when the import is for purposes that are:
(A) Primarily commercial
(B) Not primarily commercial (e.g., scientific research)
(C) Related to mass consumption
(D) Unregulated by the importing state

2019
297. Under the CMS, states that exercise jurisdiction over any part of the range of a migratory species are obligated to:
(A) Maximize commercial extraction
(B) Conserve and restore habitats important to the species
(C) Erect physical barriers to prevent migration
(D) Eradicate the species if it competes with fisheries

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2011
298. Ramsar sites are added to the Montreux Record specifically when they:
(A) Experience positive ecological growth
(B) Are threatened by technological developments, pollution, or other human interference
(C) Are completely pristine and untouched
(D) Are located in international waters

2017
299. MARPOL Annex V places the strictest restrictions on garbage discharge in designated:
(A) Special Areas (e.g., the Mediterranean Sea)
(B) High Seas outside any EEZ
(C) Deep-sea trenches
(D) Equatorial waters

2014
300. What was the primary objective of the International Whaling Commission's 1986 commercial whaling moratorium?
(A) Establish a permanent and legally binding

(A) Internal waters
(B) Contiguous zone
(C) High seas or EEZ
(D) Continental shelf

2012

230. Within the Contiguous Zone, the coastal state does NOT have sovereign rights over:
(A) Sanitary enforcement
(B) Customs regulations
(C) Immigration laws
(D) Airspace above the zone

2005

231. The Indian Fisheries Act (1897) applies primarily to:
(A) Internal waters and the territorial sea
(B) The High Seas
(C) The entire Indian EEZ
(D) International straits

2016

232. Violations of MFRA gear regulations (like cod-end mesh size) usually result in:
(A) Immediate sinking of the vessel
(B) Confiscation of the illegal gear and imposition of fines
(C) International tribunals
(D) Transfer of the vessel to the state navy

2005

233. The Murari Committee (1995) was established following protests primarily led by:
(A) The National Fishworkers Forum against foreign deep-sea vessels
(B) Foreign investors against Indian taxation
(C) Aquaculture farmers against marine limits
(D) Conservation NGOs against traditional fishing

2012

234. The Water (Prevention and Control of Pollution) Act was enacted in India in which year?
(A) 1972
(B) 1974
(C) 1981
(D) 1986

2009

235. The giant grouper (Epinephelus lanceolatus) is notable in Indian conservation because it is:
(A) Promoted for open-access commercial fishing
(B) Listed under Schedule I of the Wildlife (Protection) Act (1972)
(C) Considered an invasive pest
(D) Extinct in the wild

2008

236. The MZI Act (1981) mandates that the Central Government may define the EEZ limits and coordinates by:
(A) Issuing a notification in the Official Gazette
(B) Informing local fishermen orally
(C) Passing a resolution in the UN General Assembly
(D) Consulting foreign navies

2006

237. The benefit-sharing formula under the Biological Diversity Act (2002) is determined by the:
(A) State Police
(B) National Biodiversity Authority in consultation with local BMCs
(C) Foreign patent office
(D) Importer of the biological resource

2005

238. CRZ clearances for permitted activities are generally granted by the:
(A) Ministry of Earth Sciences
(B) Indian Coast Guard
(C) Coastal Zone Management Authority (State/National)
(D) MPEDA

2018

239. The NPMF (2017) emphasizes the use of Artificial Reefs (ARs) and Fish Aggregating Devices (FADs) to:
(A) Block navigation channels
(B) Assist foreign vessels in locating fish
(C) Eradicate benthic ecosystems
(D) Enhance coastal fishery resources and livelihoods

NODIA

2022

240. MPEDA acts as the nodal agency for establishing which traceability mechanism for Indian seafood exports?
(A) Catch certification schemes for EU compliance
(B) MSC green labeling
(C) CITES permits
(D) RFMO quota allocations

2001

241. A fishery failing to meet MSC Principle 1 (sustainable fish stocks) may still operate but cannot:
(A) Sell fish locally
(B) Obtain or retain the MSC ecolabel for its products
(C) Use mechanized vessels

(D) Export to any country

2010

242. The EU Fish Catch Certificate requirement primarily shifts the burden of proof regarding legality to the:
(A) Retail consumer
(B) Flag state of the catching vessel
(C) European Commission
(D) Port authority in the EU

2006

243. Article 73 of UNCLOS specifies that arrested foreign vessels and their crews shall be promptly released upon:
(A) A simple apology
(B) The posting of reasonable bond or other security
(C) The completion of a trial
(D) Surrender of the vessel's flag

2022

244. The UNFSA stresses the importance of Flag State duties, compelling states to ensure their vessels do not:
(A) Participate in high seas fisheries
(B) Undermine the effectiveness of regional conservation and management measures
(C) Use satellite navigation
(D) Trade with developing nations

2025

245. Under the CCRF, states are urged to manage fishing capacity to prevent:
(A) Under-utilization of stocks
(B) Overfishing and economic inefficiency
(C) The expansion of aquaculture
(D) Technological innovation

2002

246. For species listed in CITES Appendix III, export requires an export permit only if the species originates from:
(A) Any member state
(B) The state that listed the species in Appendix III
(C) A landlocked state
(D) A non-party state

2023

247. A core obligation of CMS Parties is to protect the habitat of Appendix I species, which includes mitigating obstacles to their:
(A) Predation rates
(B) Migration
(C) Commercial harvesting
(D) Captive breeding

2008

248. The designation of a Ramsar site requires the area to possess significant value in terms of:
(A) Mineral wealth
(B) Ecology, botany, zoology, limnology, or hydrology
(C) Industrial development potential
(D) Urban planning prospects

2022

249. Which entity provides guidelines for the implementation of MARPOL Annex V on ships?
(A) FAO
(B) International Maritime Organization (IMO)
(C) UNEP
(D) IUCN

2001

250. The IWC's Revised Management Procedure (RMP) for calculating sustainable catch limits has NOT been implemented for commercial whaling primarily because:
(A) The RMP was mathematically flawed
(B) The commercial whaling moratorium remains in place
(C) Whale populations have completely recovered
(D) UNCLOS prohibited it

2014

251. Within what general timeframe are member states obligated to implement binding resolutions of the IOTC?
(A) Immediately upon the conclusion of the commission's annual session or 30 days thereafter
(B) Within the specific timeframe stipulated in the resolution, usually 120 days
(C) Following a comprehensive review of domestic maritime laws within a period of 5 years
(D) After the completion of a decade of membership or 10 years following initial adoption

2014

252. BOBP-IGO initiatives significantly address climate change adaptation for:
(A) Distant water fishing fleets
(B) Vulnerable coastal fishing communities
(C) Deep-sea hydrothermal vent organisms
(D) High seas pelagic trawlers

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2010
253. State regulatory intervention using Individual Transferable Quotas (ITQs) primarily aims to:
(A) Increase total fleet capacity
(B) Rationalize fishing effort and eliminate the race to fish
(C) Increase bycatch
(D) Decrease safety at sea

2025
254. Under UNCLOS, bays can be enclosed by straight baselines provided the closing line does not exceed:
(A) 12 nautical miles
(B) 24 nautical miles
(C) 200 nautical miles
(D) 350 nautical miles

2014
255. In the Exclusive Economic Zone, coastal states must ensure that the maintenance of living resources is not endangered by:
(A) Marine scientific research
(B) Over-exploitation
(C) Navigational traffic
(D) Submarine cables

2008
256. The historical significance of the Indian Fisheries Act (1897) lies in its approach to:
(A) Privatizing fisheries
(B) Resource conservation by prohibiting destructive fishing methods
(C) Promoting foreign investments
(D) Establishing aquaculture quotas

2013
257. MFRAs empower states to implement seasonal fishing bans (like the monsoon ban) across the:
(A) Entire EEZ
(B) Territorial waters only
(C) High seas
(D) Internal freshwaters only

2019
258. Post-Murari Committee, India's deep-sea fishing policy shifted focus towards:
(A) Expanding foreign joint ventures
(B) Empowering Indian entrepreneurs and upgrading domestic capacity
(C) Banning all deep-sea fishing indefinitely
(D) Allowing unregulated foreign access

2013
259. Effluent treatment plants (ETPs) in large-scale coastal aquaculture are mandatory under the Environmental (Protection) Act (1986) to reduce:
(A) Salinity of the ocean
(B) Nutrient loads and suspended solids before discharge
(C) The speed of ocean currents
(D) Tsunami impacts

2022
260. Sea fans (Gorgonians) are protected from extraction and trade under which legislation in India?
(A) MPEDA Act (1972)
(B) Wildlife (Protection) Act (1972)
(C) MZI Act (1981)
(D) CRZ Notification

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2022
261. Officers authorized under the MZI Act (1981) to enforce its provisions primarily include personnel from the:
(A) Customs Department and Coast Guard
(B) Ministry of Agriculture
(C) State Biodiversity Boards
(D) Inland Waterways Authority

2006
262. Under the Biological Diversity Act (2002), research results on Indian bio-resources cannot be transferred to a non-citizen without prior approval from the:
(A) Local Panchayat
(B) National Biodiversity Authority
(C) Ministry of Commerce
(D) State Government

2024
263. CRZ-I boundaries are strictly defined to protect areas such as:
(A) Developed urban shorelines
(B) Mangroves, coral reefs, and sand dunes
(C) Commercial harbors
(D) Open sea anchorages

2001
264. The NPMF (2017) supports the implementation of Minimum Legal Size (MLS) regulations to prevent:
(A) Bycatch of marine mammals
(B) Growth overfishing by restricting the capture of juveniles
(C) International boundary disputes
(D) The use of artificial reefs

2014
218. According to UNCLOS, landlocked states have the right to access living resources in which manner?
(A) Legally claim a full Exclusive Economic Zone in the nearest oceanic territory
(B) Conduct fishing operations unconditionally within the territorial seas of adjacent coastal nations
(C) Participate on an equitable basis in the surplus living resources of subregional EEZs
(D) Exercise authority to dictate maritime boundaries and jurisdictional limits for coastal states

2012
219. UNFSA provisions explicitly emphasize the protection of marine biodiversity in the:
(A) High seas and areas under national jurisdiction
(B) Territorial sea only
(C) Exclusive Economic Zone only
(D) Internal waters

2009
220. The CCRF guidelines on fishing operations (Article 8) stress the importance of:
(A) Utilizing non-selective gear to maximize yield
(B) Disabling Vessel Monitoring Systems (VMS)
(C) Minimizing waste, discards, and catch of non-target species
(D) Discharging waste oil at sea

2004
221. Which global agreement is most direct in regulating the trade of endangered seahorses?
(A) MARPOL
(B) UNCLOS
(C) IWC
(D) CITES

2012
222. Under the CMS, an MoU differs from a binding Agreement in that an MoU is:
(A) A non-legally binding administrative arrangement focusing on cooperative action
(B) A legally binding international treaty
(C) Enforceable by the International Court of Justice
(D) Applicable only to terrestrial species

2024
223. The 'Ramsar Information Sheet' is crucial because it:
(A) Dictates global fish prices
(B) Provides standard data on the ecological character of a designated Ramsar site
(C) Serves as a commercial fishing license
(D) Records shipping traffic

2019
224. Fishing vessels are exempt from the plastic discharge prohibitions of MARPOL Annex V under what condition?
(A) If the plastic is shredded first
(B) If the vessel is beyond 200 nm from land
(C) Under no condition, except accidental loss where all reasonable precautions were taken
(D) If the plastic is weighted to sink

2018
225. The IWC's moratorium on commercial whaling applies specifically to:
(A) All cetaceans, including small dolphins
(B) Walruses and seals
(C) Marine turtles
(D) Large whale species targeted commercially

2025
226. IOTC's mandate covers tuna and tuna-like species in the Indian Ocean, as well as:
(A) Managing bycatch associated with tuna fisheries
(B) Demersal finfish like croakers
(C) Benthic crustaceans
(D) Setting coastal aquaculture standards

2011
227. The Bay of Bengal Programme (BOBP-IGO) emphasizes the ecosystem approach by focusing on the nexus between fisheries management and:
(A) Deep-sea oil drilling
(B) Coastal environmental degradation and community livelihoods
(C) International shipping lane expansion
(D) High seas piracy

2025
228. State intervention via licensing limits entry into a fishery, effectively mitigating the tragedy of the commons by transforming the resource from open access to:
(A) Private property
(B) A regulated common property resource
(C) A pure public good
(D) An unregulated monopoly

2018
229. An archipelagic baseline cannot be drawn if it completely cuts off the territorial sea of another state from the:

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(A) Large-scale pelagic driftnets
(B) Eco-friendly and fuel-efficient fishing technologies
(C) Explosives for efficient harvesting
(D) Bottom trawling in coral reefs

2024
278. The Tragedy of the Commons implies that without regulation, individual fishers have no incentive to:
(A) Buy new gear
(B) Leave fish in the water to reproduce
(C) Sell fish at market prices
(D) Compete with other fishers

2018
279. The outer limit of the territorial sea is measured from the:
(A) Contiguous zone boundary
(B) High-water mark
(C) Baseline
(D) Continental shelf break

2005
280. If the distance between two opposite states is less than 400 nm, their EEZ boundaries are typically determined by:
(A) Drawing a median line or reaching a bilateral delimitation agreement
(B) Awarding the entire area to the state with the larger fleet
(C) A random lottery drawn by the UN
(D) Establishing an unregulated high seas corridor

2016
281. The Indian Fisheries Act (1897) prohibits the destruction of fish by explosives under which section?
(A) Section 4
(B) Section 5
(C) Section 6
(D) Section 7

2021
282. State MFRAs strictly regulate the use of purse seines in territorial waters to:
(A) Encourage foreign fleet entry
(B) Prevent mass capture of juvenile pelagic shoals and resource depletion
(C) Increase the profitability of large corporations
(D) Eradicate small pelagic species

2004
283. India's deep-sea fishing policy mandates that deep-sea vessels must primarily target resources beyond:
(A) The High Seas
(B) 12 nautical miles (territorial waters)
(C) The 200 nautical mile EEZ
(D) Inland reservoirs

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2015
284. Under the Environmental (Protection) Act (1986), coastal aquaculture authorities regulate the use of:
(A) Navigation lights on fishing boats
(B) Antibiotics and pharmacologically active substances in shrimp farms
(C) Sails on traditional crafts
(D) Echo sounders

2018
285. Which of the following is an offense under the Wildlife (Protection) Act (1972) regarding Schedule I marine species?
(A) Photographing them in the wild
(B) Hunting, possessing, or trading them without explicit authorization
(C) Observing them from a distance
(D) Conducting non-invasive scientific surveys

2007
286. Confiscated foreign vessels under the MZI Act (1981) are adjudicated by:
(A) International maritime courts
(B) Designated Indian courts
(C) The UN Security Council
(D) The flag state's naval tribunal

2024
287. Equitable sharing of benefits under the Biological Diversity Act (2002) may include:
(A) Granting joint ownership of intellectual property rights
(B) Surrendering state sovereignty over the EEZ
(C) Banning local communities from the forests
(D) Deporting foreign researchers

2021
288. Under CRZ rules, the No Development Zone (NDZ) in CRZ-III is typically measured from the:
(A) High Tide Line landward up to a specified distance (e.g., 200 meters)
(B) Low Tide Line seaward to 12 nm
(C) Baseline to the EEZ limit
(D) Center of a coastal city

2012
265. NFDB schemes provide financial assistance for the development of:
(A) Deep-sea mining equipment
(B) Modern fish markets and hygienic retail outlets
(C) Foreign naval bases
(D) Offshore oil rigs

2014
266. Principle 3 of the MSC standard requires fisheries to have an effective:
(A) Marketing strategy
(B) Management system that respects local, national, and international laws
(C) Strategy to completely eliminate traditional fishers
(D) Subsidized fuel program

2014
267. Under UNCLOS, a coastal state has the exclusive right to construct and authorize the construction of artificial islands within its:
(A) Territorial Sea only
(B) Exclusive Economic Zone and Continental Shelf
(C) High Seas
(D) Contiguous Zone only

2003
268. Under UNCLOS, a coastal state must determine its capacity to harvest the living resources of the EEZ and grant other states access to the:
(A) Entire biomass
(B) Surplus of the allowable catch
(C) Demersal species only
(D) Breeding stock

2006
269. The UNFSA establishes that if a state is not a member of a relevant RFMO, it must:
(A) Fish without any restrictions
(B) Apply the conservation measures established by that RFMO or not fish for the resource
(C) Appeal to the UN Security Council
(D) Disregard UNFSA completely

2021
270. The FAO CCRF encourages states to ensure that their fisheries policies are:
(A) Secret and classified
(B) Transparent and inclusive of all stakeholders
(C) Dictated solely by international corporations
(D) Based solely on historical mythology

2025
271. Species listed under CITES Appendix II require which document for lawful international trade?
(A) Import permit only
(B) Export permit issued by the Management Authority of the exporting state
(C) Certification of commercial viability
(D) No documentation is required

2016
272. The overarching goal of the CMS is to conserve terrestrial, aquatic, and avian migratory species throughout their:
(A) Wintering grounds only
(B) Breeding grounds only
(C) Entire range
(D) Marine phases only

2024
273. The Ramsar Convention encourages Contracting Parties to integrate wetland conservation into their:
(A) Space exploration programs
(B) National land-use planning
(C) Deep-sea mining regulations
(D) Military defense strategies

2005
274. In the context of MARPOL Annex V, "ghost fishing" refers to:
(A) Fishing at night without lights
(B) Fishing by unregistered vessels
(C) The continued capture of marine life by discarded or lost fishing gear
(D) Fishing for translucent pelagic species

2001
275. The International Whaling Commission allows aboriginal subsistence whaling because it:
(A) Generates significant export revenue
(B) Satisfies nutritional and cultural needs without threatening stocks
(C) Is impossible to regulate
(D) Uses highly mechanized factory ships

2021
276. IOTC scientific committees provide advice primarily based on:
(A) Political lobbying
(B) Stock assessments and fisheries data submitted by member states
(C) Random sampling of consumer preferences
(D) Satellite imagery of plankton alone

2024
277. The BOBP-IGO supports artisanal fisheries by promoting the use of:

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ban on all forms of global whaling forever

(B) Pause commercial whaling to allow whale stocks to recover and undergo scientific assessment

(C) Implement strict regional restrictions on all traditional aboriginal subsistence whaling activities

(D) Provide extensive financial subsidies to modernize the international commercial whaling industry

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53. (A) The economic inefficiencies and stock depletion of open access
State regulatory intervention in marine fisheries is fundamentally necessary to counteract market failures associated with common-pool resources. Under open-access conditions, individual fishers lack incentives to conserve fish stocks, leading to a race to fish. This unrestricted exploitation results in severe economic inefficiencies, overcapitalization of the fleet, and rapid biological depletion of target marine species.

54. (B) Establishing the inner limit of all maritime jurisdictional zones
Under the United Nations Convention on the Law of the Sea, the baseline is the foundational line from which all seaward maritime zones are measured. It establishes the inner boundary of the territorial sea, the contiguous zone, the exclusive economic zone, and the continental shelf, making it crucial for defining a coastal state's sovereign rights.

55. (D) A is false but R is true.
The exclusive economic zone does not grant coastal states absolute territorial sovereignty equivalent to that of the territorial sea. While the territorial sea is an extension of a state's sovereign land territory, the exclusive economic zone is a specific maritime zone where the coastal state possesses sovereign rights solely for exploring, exploiting, conserving, and managing natural resources.

56. (D) Prohibit destructive fishing practices like dynamiting and poisoning
The Indian Fisheries Act of 1897 is a landmark piece of environmental legislation in South Asia. It was the first central statute in India to address resource conservation by prohibiting highly destructive harvesting methods. Specifically, the act outlawed the use of dynamite, other explosives, and noxious poisons to catch or destroy fish in internal and coastal waters.

57. (A) Conflict with traditional non-mechanized craft
State Marine Fishing Regulation Acts utilize spatial zoning to segregate different sectors of the fishing fleet. Restricting mechanized vessels like bottom trawlers to offshore areas is primarily intended to prevent physical conflict and gear damage to traditional, non-mechanized craft. This zonation also protects vulnerable coastal nursery grounds from the ecological impacts of intensive industrial trawling.

58. (A) Deep Sea Fishing Policy (1991) → Murari Committee → NPMF (2017)
The governance of India's deep-sea fisheries has evolved through distinct policy shifts. The 1991 Deep Sea Fishing Policy initially promoted foreign joint ventures, which sparked major protests by domestic fishers. This conflict led to the appointment of the Murari Committee in 1995 to review the policy, eventually paving the way for the National Policy on Marine Fisheries in 2017.

59. (B) Suspended solids, BOD, and dissolved oxygen
Effluent discharge rules under the Environmental Protection Act of 1986 require coastal aquaculture operators to monitor specific water quality parameters. Farms must systematically analyze levels of total suspended solids, biochemical oxygen demand, and dissolved oxygen in their wastewater. Regulating these parameters prevents the deterioration of coastal water quality and protects adjacent estuarine habitats from eutrophication.

60. (B) I and III
Schedule I of the Wildlife Protection Act of 1972 provides the highest legal protection to endangered wildlife in India, including the whale shark and various reef-building corals. It is incorrect to claim that this schedule includes common edible marine teleosts or that it permits regulated commercial trade of listed species, as hunting and trading them are strictly prohibited.

61. (D) Indian Coast Guard
The Indian Coast Guard is the primary maritime law enforcement agency responsible for enforcing the Maritime Zones of India Act of 1981. Coast Guard vessels and aircraft patrol the exclusive economic zone to detect, board, and apprehend unauthorized foreign fishing vessels, thereby protecting sovereign marine resources and maintaining national security within India's maritime boundaries.

62. (A) Advise state governments on conservation and regulate commercial use of bio-resources
The Biological Diversity Act of 2002 establishes State Biodiversity Boards in every Indian state. The primary function of these boards is to advise

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strictly prohibits foreign ships from engaging in commercial harvesting operations in the exclusive economic zone unless they obtain a valid license or permit from the central government, thereby protecting sovereign biological resources from unauthorized international exploitation.

10. (A) I and III
The Biological Diversity Act of 2002 provides a comprehensive legal framework for conserving biological resources in India. It establishes the National Biodiversity Authority to oversee conservation and equitable benefit sharing. The legislation strictly regulates access to biological resources and associated traditional knowledge while maintaining state-level biodiversity boards rather than abolishing them, ensuring decentralized environmental governance across the country.

11. (A) Ecologically sensitive areas and geomorphological features
Coastal Regulation Zone notifications categorize the coastal environment into distinct zones to regulate developmental activities. CRZ-I is specifically designated for ecologically sensitive areas and unique geomorphological features, such as mangroves, coral reefs, national parks, and marine sanctuaries. This critical designation imposes the strictest development restrictions to preserve fragile ecosystems from irreversible anthropogenic destruction.

12. (C) Sustainable practices and ecosystem approaches
The National Policy on Marine Fisheries of 2017 guides the development of the marine fisheries sector in India. It strongly emphasizes the adoption of sustainable fishing practices and ecosystem-based management approaches. By focusing on resource health, social security of fishers, and spatial closures, the policy seeks to balance economic growth with ecological conservation within the exclusive economic zone.

13. (D) Setting quality control standards for seafood exports
The Marine Products Export Development Authority Act of 1972 establishes a statutory body responsible for promoting and regulating marine product exports from India. A core mandate of this authority involves setting stringent quality control and safety standards for processed seafood. This ensures compliance with international sanitary regulations, thereby enhancing the global competitiveness and market reputation of Indian fisheries products.

14. (C) Seafood traceability from certified fishery to consumer
The Marine Stewardship Council implements a comprehensive ecolabeling program to reward sustainable fishing practices. Within this framework, chain of custody certification ensures complete traceability of seafood products from the certified sustainable fishery to the final consumer. This tracking mechanism prevents uncertified, illegally caught, or unsustainable products from entering the supply chain and being sold as certified seafood.

15. (B) Preventing vessels engaged in IUU fishing from using ports and landing catches
The Port State Measures Agreement is a binding international treaty designed to eliminate illegal, unreported, and unregulated fishing. It achieves this goal by restricting foreign fishing vessels from entering or utilizing port services if they are suspected of illicit activities. Denying port access prevents these vessels from landing their catches, effectively blocking illegal seafood from entering global commercial markets.

16. (D) Freedom of fishing subject to treaty obligations and conservation duties
Under the United Nations Convention on the Law of the Sea, the high seas are open to all nations. This freedom of fishing is not absolute; it is legally constrained by international treaty obligations and the duty of states to cooperate in conserving living marine resources, ensuring that global stocks are maintained at levels that support maximum sustainable yield.

17. (A) Straddling and highly migratory fish stocks
The United Nations Fish Stocks Agreement provides a detailed regulatory framework under the Law of the Sea. It focuses specifically on the conservation and sustainable management of straddling fish stocks and highly migratory species. The agreement mandates international cooperation through regional fisheries management organizations to establish compatible conservation measures between exclusive economic zones and adjacent high seas areas.

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ANSWERS

1. (A) Overcapitalization and resource depletion
Open access in unregulated fisheries allows any vessel to exploit the marine resources without limitation. This absence of property rights leads to a competitive race to fish, prompting excessive investments in vessels and gear. Consequently, the fishery suffers from overcapitalization and rapid resource depletion as individual harvesters maximize immediate catches at the expense of long-term biological sustainability.

2. (C) 24 nautical miles
The United Nations Convention on the Law of the Sea defines the contiguous zone as a band of water extending beyond the territorial sea. This zone may not extend beyond twenty-four nautical miles from the baselines from which the breadth of the territorial sea is measured, allowing coastal states to exercise control over customs, fiscal, immigration, and sanitary laws.

3. (A) Sovereign rights for exploring and exploiting natural resources
Within the exclusive economic zone, which extends up to two hundred nautical miles from the coastal baseline, the coastal state does not possess full territorial sovereignty. Instead, it exercises specific sovereign rights for the purpose of exploring, exploiting, conserving, and managing natural resources, whether living or non-living, of the waters superjacent to the seabed and of the seabed.

4. (D) P-1, Q-2, R-3, S-4
The Indian Fisheries Act of 1897 outlines specific regulatory powers and prohibitions across its sections. Section four prohibits the use of explosives to catch or destroy fish, while section five addresses the use of poisons. Section six empowers the state government to make rules, and section seven authorizes arrest without a warrant for specific offenses designated under this historic legislation.

5. (B) The monsoon trawl ban
State Marine Fishing Regulation Acts utilize seasonal closures as a primary management tool to conserve marine resources. The annual monsoon trawl ban temporarily suspends mechanized fishing activities in territorial waters. This temporal restriction protects spawning fish populations during their peak breeding season, preventing recruitment overfishing and helping to rebuild depleted wild stocks for sustainable future harvesting by coastal communities.

6. (C) Rescinding licenses of foreign vessels operating in the EEZ
The Murari Committee was appointed in India to review the deep-sea fishing policy following widespread protests by traditional fishers. The committee recommended rescinding all operational licenses issued to foreign joint venture vessels within the exclusive economic zone. This historic recommendation aimed to protect domestic fisherfolk from unequal competition and safeguard territorial marine resources from unsustainable industrial exploitation.

7. (D) Biochemical Oxygen Demand (BOD) limits
The Environmental Protection Act of 1986 regulates coastal aquaculture operations to prevent habitat degradation from wastewater discharges. Compliance frameworks emphasize monitoring biochemical oxygen demand limits in the discharged effluent. Restricting these levels ensures that organic waste from shrimp and fish ponds does not deplete dissolved oxygen in receiving coastal waters, thereby protecting fragile marine ecosystems and surrounding biota.

8. (C) Certain species of marine turtles and cetaceans
Schedule I of the Wildlife Protection Act of 1972 grants the highest level of legal protection to threatened fauna in India. This designation includes vulnerable marine organisms such as specific marine turtles and cetaceans, including the Indo-Pacific humpback dolphin and olive ridley turtles. Harvesting, hunting, or trading these strictly protected species attracts severe legal penalties and enforcement measures.

9. (B) Fishing in the Indian EEZ without a valid license or permit
The Maritime Zones of India Act of 1981 regulates fishing activities by foreign vessels within Indian maritime boundaries. The legislation

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seeks to maximize private gain by increasing fishing effort. While the individual receives all benefits from harvesting an additional fish, the negative consequences of resource depletion are shared collectively, inevitably driving the stock toward collapse.

27. (A) Low-water line along the coast as marked on large-scale charts
Under the United Nations Convention on the Law of the Sea, maritime jurisdictional zones are measured from a designated baseline. The normal baseline is defined as the low-water line along the coast, as officially marked on large-scale charts recognized by the coastal state. This line separates internal landward waters from seaward maritime zones.

28. (C) Territorial Sea, Contiguous Zone, EEZ, High Seas
The United Nations Convention on the Law of the Sea establishes a clear seaward progression of maritime zones from the baseline. Immediately adjacent is the territorial sea extending up to twelve nautical miles, followed by the contiguous zone up to twenty-four nautical miles. The exclusive economic zone extends to two hundred miles, beyond which lie the high seas.

29. (D) Preventing over-exploitation through appropriate conservation measures
The concept of maximum sustainable yield is a key biological reference point embedded in the exclusive economic zone framework of the Law of the Sea. It obliges coastal states to utilize scientific evidence to prevent the over-exploitation of living resources. States must implement appropriate conservation and management measures to maintain harvested populations at sustainable reproductive levels.

30. (C) I, II and IV
The Indian Fisheries Act of 1897 represents the earliest central legislation regulating fisheries in India. Enacted during the pre-independence era, this statute penalizes destructive practices, specifically the use of explosives and poisons for catching fish in territorial waters. It also delegates legislative authority to state governments, allowing them to formulate customized fishery rules within their jurisdictions.

31. (C) Protecting traditional non-mechanized fishers
State Marine Fishing Regulation Acts incorporate spatial zonation to manage coastal waters. By restricting mechanized vessels, such as bottom trawlers, to offshore areas beyond a specific distance or depth, these regulations reserve nearshore waters for traditional, non-mechanized craft. This spatial division protects the livelihoods of artisanal fishers and shields sensitive nearshore nursery grounds from habitat destruction.

32. (D) Facilitating the acquisition of resource-specific vessels
The Letter of Permission scheme was introduced under India's deep-sea fishing policies to encourage the exploitation of offshore resources. The primary objective of this regulatory mechanism was to facilitate the acquisition and operation of resource-specific vessels by Indian entrepreneurs. It aimed to tap underutilized pelagic and demersal stocks in the exclusive economic zone using modern technology.

33. (A) Exceeding prescribed limits for suspended solids and nutrients
Under the Environmental Protection Act of 1986, coastal aquaculture units must comply with strict effluent discharge standards. Farms are required to treat their wastewater to ensure it does not exceed prescribed threshold limits for suspended solids, nitrogen, phosphorus, and organic matter. This prevents eutrophication and chemical pollution in adjacent coastal lagoons, estuaries, and marine systems.

34. (B) P-2, Q-3, R-4, S-1
Different marine taxa are managed under specific legal and conservation frameworks. In India, marine turtles are strictly protected under Schedule I of the Wildlife Protection Act. Globally, endangered cetaceans are managed under the International Whaling Commission. Highly migratory stocks are governed by the United Nations Fish Stocks Agreement, while threatened corals in international trade are regulated by CITES.

35. (B) Ensuring compliance with fishing licenses and regulations
The Maritime Zones of India Act of 1981 empowers enforcement agencies, such as the Indian Coast Guard, to board foreign vessels

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within the exclusive economic zone. This monitoring action is conducted primarily to ensure compliance with national laws, verify the validity of fishing licenses, and inspect physical gear and catch logs to prevent unauthorized fishing.

36. (C) The commercial utilization of biological resources
The access and benefit sharing mechanism under the Biological Diversity Act of 2002 ensures that benefits derived from the commercial utilization of biological resources are shared equitably with local communities. This legal framework requires commercial entities to obtain prior approval before accessing local genetic material, supporting both biodiversity conservation and the livelihoods of traditional knowledge holders.

37. (D) CRZ-IV
Coastal Regulation Zone notifications categorize the coastal environment into four primary zones to regulate land and water use. CRZ-IV specifically covers the marine water area extending from the low tide line seaward up to twelve nautical miles, as well as water bodies influenced by tidal action. Management in this zone focuses on controlling pollution and discharges.

38. (C) A is true but R is false.
The National Policy on Marine Fisheries of 2017 advocates for integrated management frameworks across marine and inland capture fisheries sectors to optimize resource use. However, the policy does not prohibit mariculture within the exclusive economic zone. Instead, it actively promotes offshore mariculture, cage farming, and seaweed cultivation as viable options to augment national fish production and income.

39. (A) Providing subsidies and infrastructure for fisheries development
The National Fisheries Development Board plays a key role in boosting the Indian fisheries sector. It is responsible for providing financial assistance, subsidies, and infrastructural support to state governments and local fishers. These initiatives focus on upgrading aquaculture production, modernizing fish landing centers, establishing hygienic markets, and enhancing the overall value chain of aquatic products.

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40. (B) I only
The Marine Stewardship Council ecolabeling program provides market-based incentives for sustainable capture fisheries. This system relies on traceability through a verified chain of custody to assure consumers of resource sustainability. However, ecolabeling does not guarantee zero environmental impact, as all fishing operations affect ecosystems; rather, it certifies that impacts are minimized and kept within sustainable ecological limits.

41. (C) Document that imported fish was caught in compliance with conservation laws
The European Union Catch Certificate is an essential trade document designed to combat illegal, unreported, and unregulated fishing. It requires flag states to formally certify that marine catches imported into the European market were harvested in full compliance with established conservation and management regulations, thereby preventing illicitly sourced seafood from entering commercial supply chains.

42. (D) Domestic state courts of the infringing vessel
Under the United Nations Convention on the Law of the Sea, compulsory dispute settlement mechanisms exist to resolve international maritime conflicts. These include the International Tribunal for the Law of the Sea, the International Court of Justice, and special arbitral tribunals. Domestic state courts of an infringing vessel are not recognized as compulsory international dispute resolution bodies under the treaty.

43. (A) Regional Fisheries Management Organizations (RFMOs))
Under the United Nations Fish Stocks Agreement, the management and allocation of catch quotas for straddling and highly migratory fish stocks are implemented through Regional Fisheries Management Organizations. These international bodies coordinate cooperation between coastal states and distant water nations, utilizing scientific stock assessments to distribute sustainable harvest limits among member countries.

44. (C) Single-species yield to broader ecosystem health
The ecosystem approach to fisheries, promoted by the Food and Agriculture Organization, shifts the focus of marine resource management.

It transitions from traditional single-species models that only maximize physical yield to a holistic approach. This broader framework considers bycatch, habitat conservation, trophic interactions, and the socio-economic well-being of coastal communities dependent on the marine ecosystem.

45. (A) III, I, IV, II
Maritime regulatory frameworks operate across distinct geographical scales. The Indian Coastal Regulation Zone notifications apply specifically to narrow intertidal land and nearshore waters. State Marine Fishing Regulation Acts govern territorial waters up to twelve nautical miles. Regional Fisheries Management Organizations manage shared stocks across ocean basins, while the United Nations Convention on the Law of the Sea provides a global framework.

46. (A) Are not necessarily threatened with extinction, but trade must be controlled
Appendix II of the Convention on International Trade in Endangered Species lists organisms that are not currently threatened with extinction but may become so unless their trade is strictly regulated. International trade in these species is permitted only through the issuance of export permits, which certify that the harvest was legal and non-detrimental to the species' survival.

47. (C) Development of regional Memorandums of Understanding (MoUs))
The Convention on Migratory Species utilizes various instruments to conserve vulnerable migratory animals. For aquatic species like marine turtles, cetaceans, and sharks, the convention facilitates the development of regional Memorandums of Understanding. These non-binding administrative instruments foster international cooperation, coordinate scientific research, and implement joint conservation plans across the migratory pathways of shared transboundary species.

48. (A) II, III, I, IV
Designating a wetland of international importance under the Ramsar Convention involves a logical sequence of administrative steps. First, a wetland meeting specific international criteria must be identified. Second, the national government submits a formal proposal. Third, the Ramsar Secretariat officially designates and lists the site. Finally, a wise-use management plan is implemented to ensure long-term conservation.

49. (B) All plastics, including synthetic ropes and fishing nets
Annex V of the MARPOL Convention addresses marine pollution by regulating garbage discharge from all types of vessels. Under these international rules, the disposal of all plastics, including synthetic fishing nets, lines, and diagnostic gear, is strictly prohibited worldwide. This regulation is crucial for preventing the accumulation of persistent synthetic debris that causes ghost fishing and wildlife entanglement.

50. (A) I and III
The International Whaling Commission is the global body charged with the conservation of whales and the management of whaling. Under its mandate, the commission instituted a highly effective moratorium on commercial whaling in 1986 and established specific whale sanctuaries in the Indian and Southern Oceans. It does not regulate marine turtles or completely ban aboriginal subsistence whaling.

51. (C) Implement domestic catch limits and gear restrictions for tuna
As a Regional Fisheries Management Organization, the Indian Ocean Tuna Commission adopts binding resolutions that require member states to implement specific conservation measures. Members are legally obligated to translate these resolutions into national legislation, which includes enforcing catch limits, regulating vessel registries, implementing observer programs, and enforcing gear restrictions to ensure the sustainable harvest of tuna stocks.

52. (D) Safety at sea and community capacity building
The Bay of Bengal Programme Inter-Governmental Organisation works to improve coastal fisheries management among its member countries. The organization enhances the governance of artisanal fisheries by prioritizing fishers' safety at sea, promoting low-impact fishing technologies, and fostering community capacity building. These efforts help small-scale fishing communities build resilience against economic vulnerability and ecological changes.

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18. (C) A voluntary framework integrating the ecosystem approach to fisheries
The Food and Agriculture Organization developed the Code of Conduct for Responsible Fisheries as a global reference instrument. This voluntary, non-binding framework outlines principles and international standards for sustainable fisheries management. It integrates the ecosystem approach to fisheries, promoting responsible practices in capture fisheries, aquaculture, post-harvest operations, and trade to ensure long-term global food security and marine conservation.

19. (A) Are threatened with extinction and subject to strict commercial trade bans
The Convention on International Trade in Endangered Species of Wild Fauna and Flora protects vulnerable taxa through different appendices. Appendix I lists species that are threatened with extinction and are directly affected by international trade. Consequently, commercial trade in wild specimens of these listed species is strictly prohibited, and non-commercial movement is permitted only under exceptional, highly regulated circumstances.

20. (D) II and IV
The Convention on Migratory Species, commonly known as the Bonn Convention, is an intergovernmental treaty dedicated to conserving terrestrial, marine, and avian migratory species throughout their ranges. It facilitates binding agreements and cooperative memorandums of understanding for diverse aquatic species like marine turtles and cetaceans. It does not regulate global tuna quotas or restrict its scope exclusively to terrestrial birds.

21. (B) Wise-use principle
The Ramsar Convention on Wetlands promotes the conservation and sustainable management of wetland ecosystems globally. The central concept guiding this framework is the wise-use principle, defined as the maintenance of wetland ecological character through the implementation of ecosystem approaches. This allows human utilization of resources in a sustainable manner that does not compromise the natural functionality of the wetland.

22. (C) Garbage, including the disposal of plastic fishing gear
The International Convention for the Prevention of Pollution from Ships contains various technical annexes to address marine pollution. Annex V specifically regulates the discharge of garbage from vessels. It strictly prohibits the disposal of all plastics, including synthetic fishing nets and ropes, into the ocean, thereby mitigating the severe ecological threats associated with marine debris and ghost fishing.

23. (D) Aboriginal subsistence whaling
The International Whaling Commission regulates global whaling activities to conserve whale populations. While a commercial whaling moratorium has been in place since 1986, the commission provides specific exemptions for aboriginal subsistence whaling. This allowance enables indigenous communities to harvest whales to meet their documented cultural and nutritional needs, provided the hunts do not threaten stock recovery.

24. (A) Regional Fisheries Management Organization (RFMO))
The Indian Ocean Tuna Commission is an intergovernmental organization established under the Food and Agriculture Organization. It functions as a Regional Fisheries Management Organization responsible for the conservation and sustainable management of tuna and tuna-like species in the Indian Ocean. It coordinates scientific stock assessments and issues binding conservation resolutions to its member states.

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25. (B) Promoting artisanal coastal fisheries and capacity-building
The Bay of Bengal Programme Inter-Governmental Organisation is a regional fisheries body representing member nations around the bay. It focuses fundamentally on promoting sustainable artisanal and small-scale coastal fisheries. Through training programs, safety at sea initiatives, and capacity-building workshops, the organization helps coastal communities improve their resource management practices and enhance local livelihoods.

26. (B) A rational fisher will increase effort because the cost of depletion is shared by all
The Tragedy of the Commons model assumes that in an open-access fishery, individual fishers act as rational economic agents. Each fisher

state governments on biodiversity conservation, sustainable resource use, and equitable benefit sharing. They also regulate requests for commercial utilization or bio-survey of biological resources by Indian citizens, ensuring regional compliance with conservation goals.

63. (C) Setting up new industries or expanding existing ones
CRZ-I comprises ecologically sensitive coastal areas that are critical for maintaining marine biodiversity. To preserve these fragile environments, Coastal Regulation Zone notifications strictly prohibit major developmental and industrial activities in this zone. Prohibited actions include setting up new industries, expanding existing industrial facilities, and disposing of hazardous wastes, while allowing restricted traditional activities like artisanal fishing.

64. (A) P-3, Q-1, R-2, S-4
India's coastal and marine governance consists of diverse policy instruments. The National Policy on Marine Fisheries of 2017 provides a comprehensive fisheries strategy. The MPEDA Act focuses on seafood export quality and promotion, while Coastal Regulation Zone notifications manage land-use zonation. The Maritime Zones of India Act of 1981 regulates foreign fishing vessels in national waters.

65. (B) Increase fisheries production and productivity
The National Fisheries Development Board was established to coordinate fisheries development activities in India. A core aspect of its mandate involves providing technical guidance, capacity building, and financial assistance to modernise aquaculture and capture fisheries. These targeted interventions aim to increase overall fish production, improve productivity, and enhance the socio-economic welfare of fishers across the country.

66. (C) Consumers can identify products derived from sustainable fisheries
Ecolabeling in fisheries is a market-based conservation mechanism that bridges resource management and consumer choice. It allows independent bodies to certify fisheries that meet strict environmental sustainability standards. Certified products carry a visible label, enabling retail consumers to easily identify and purchase seafood harvested from sustainably managed, non-depleted wild fish stocks.

67. (A) Flag of Convenience
The term Flag of Convenience refers to a maritime business practice where a ship owner registers a commercial vessel under the registry of a foreign nation. This choice is primarily motivated by the desire to bypass stringent tax laws, avoid strict labor and safety regulations, or evade international fisheries conservation measures enforced by the owner's home state.

68. (D) A is false but R is true.
Coastal states do not possess any territorial or resource jurisdiction over the high seas under the Law of the Sea. Instead, the high seas are open to all states, representing a global common area. While nations enjoy the freedom of fishing in these international waters, this right is legally coupled with the duty to conserve living resources.

69. (A) Cooperate directly or through RFMOs to ensure conservation
The United Nations Fish Stocks Agreement establishes a legal framework for managing fish populations that cross multiple jurisdictions. For straddling fish stocks, the agreement mandates that coastal states and distant water nations cooperate directly or through Regional Fisheries Management Organizations. This collaboration is essential to establish compatible, science-based conservation measures across administrative boundaries.

70. (A) II and III
The FAO Code of Conduct for Responsible Fisheries is a comprehensive global framework designed to guide sustainable aquatic resource management. It is a voluntary, non-binding instrument that actively promotes the ecosystem approach to fisheries. Its guidelines cover the entire sector, including capture fisheries, aquaculture development, post-harvest processing, and international seafood trade practices.

71. (B) Are protected in at least one country, which has requested assistance in controlling trade
Appendix III of the Convention on International Trade in Endangered Species serves a distinct regulatory purpose. It contains species that are protected within the jurisdiction of at least one country that has requested assistance from

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other treaty parties to monitor and control international trade. This mechanism helps prevent illegal exploitation of locally vulnerable marine and terrestrial organisms.

72. (C) Coordinated international conservation and management plans
The Convention on Migratory Species utilizes regional Memorandums of Understanding to protect highly migratory marine turtles. These cooperative agreements facilitate coordinated international conservation and management plans across the nesting beaches, foraging areas, and migration corridors of various range states. This shared responsibility is crucial for mitigating transboundary threats like bycatch and habitat destruction.

73. (D) Supporting vulnerable, endangered, or critically endangered species
To be designated as a Wetland of International Importance under the Ramsar Convention, a site must meet specific ecological criteria. A key criterion is whether the wetland regularly supports vulnerable, endangered, or critically endangered species, or threatened ecological communities. This biological significance highlights the wetland's critical role in conserving global biodiversity and protecting fragile aquatic habitats.

74. (A) Ghost fishing
The strict prohibition of fishing gear disposal into the ocean under MARPOL Annex V directly addresses a major threat to marine biodiversity. Discarded, lost, or abandoned synthetic nets and lines continue to float in the water column indefinitely. This leads to ghost fishing, where marine animals are continuously trapped, entangled, and killed without human intervention.

75. (B) Protecting feeding grounds and prohibit commercial whaling in the area
The International Whaling Commission established the Southern Ocean Whale Sanctuary as a designated marine protected area. This initiative aims to protect the critical summer feeding grounds of several large whale species by completely prohibiting commercial whaling activities within the sanctuary's boundaries, thereby supporting the long-term recovery of depleted baleen whale populations in the region.

76. (C) Historical catches, scientific advice, and coastal state rights
Regional Fisheries Management Organizations are responsible for allocating sustainable harvest quotas for shared fish stocks. These allocations are determined through multilateral negotiations based on key objective criteria, including the historical catch records of member fleets, independent scientific stock assessments, and the sovereign rights of developing coastal states within whose exclusive economic zones the resources occur.

77. (D) Artisanal and small-scale coastal fisheries
The Bay of Bengal Programme Inter-Governmental Organisation directs its capacity-building and resource management programs at the artisanal and small-scale coastal fisheries sector. By focusing on this vulnerable demographic, the organization aims to improve fishing safety, reduce post-harvest losses, and introduce eco-friendly gears, thereby enhancing the economic security of millions of coastal household fishers.

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78. (A) New entrants continue fishing as long as average revenue exceeds average cost
In fisheries economics, open-access resources are characterized by the absence of property rights, leading to resource rent dissipation. Since entry is unrestricted, new vessels continue to join the fishery as long as average revenue exceeds average cost. This influx of effort continues until total revenue equals total costs, eliminating economic profits and depleting the stock.

79. (B) Serves as the starting point for measuring the Territorial Sea, Contiguous Zone, and EEZ
The baseline is a fundamental concept in international maritime law under the United Nations Convention on the Law of the Sea. It serves as the official starting point for measuring the breadth of all maritime zones, including the twelve-mile territorial sea, the twenty-four-mile contiguous zone, and the two-hundred-mile exclusive economic zone.

80. (C) I, II and IV
Under the United Nations Convention on the Law of the Sea, the continental shelf comprises the seabed and subsoil of submarine areas extending beyond the territorial sea. Coastal states exercise sovereign rights over the shelf to explore and exploit natural resources, which can

extend up to a maximum of 350 nautical miles under specific geological conditions.

81. (D) Fines and potential imprisonment
The Indian Fisheries Act of 1897 includes penal provisions to deter destructive fishing practices within its jurisdiction. Individuals found guilty of violating the act's provisions, such as using dynamite or poisons to catch fish, are subject to legal penalties. These punishments typically involve monetary fines and potential terms of imprisonment, as determined by local judicial authorities.

82. (A) Minimum mesh size regulations to prevent juvenile catch
State Marine Fishing Regulation Acts incorporate various technical measures to manage harvesting activities. A key structural constraint is the enforcement of minimum mesh size regulations for fishing gear, particularly trawl cod ends. This measure ensures that juvenile fish can escape through the net, thereby preventing growth overfishing and supporting the recruitment of wild marine populations.

83. (B) Conflicts between traditional fishers and joint venture foreign vessels
India's 1991 Deep Sea Fishing Policy generated significant controversy by promoting joint ventures with foreign fishing companies. This approach led to physical conflicts on the water between traditional, small-scale fishers and large, industrial foreign trawlers. Domestic fishworkers argued that the policy allowed foreign fleets to exploit sovereign resources, threatening coastal livelihoods and damaging local marine habitats.

84. (C) Lay down standards for the quality of environment and emission/discharge of pollutants
The Environmental Protection Act of 1986 serves as umbrella legislation for environmental management in India. It empowers the central government to take all necessary measures to protect the environment. This includes laying down comprehensive national standards for environmental quality and regulating the emission or discharge of environmental pollutants from various industrial sources, including coastal aquaculture facilities.

85. (A) I, II, III
In India, animal protection levels vary according to their classification under the Wildlife Protection Act of 1972. Common edible marine teleosts receive the lowest protection, as they are harvested commercially. Certain marine sponges and corals receive higher protection, while endangered species like the whale shark are listed under Schedule I, receiving the highest possible legal protection.

86. (B) Examine logs, fishing gear, and catch of suspected foreign vessels
The Maritime Zones of India Act of 1981 authorizes designated enforcement officers, including the Indian Coast Guard, to board suspect vessels. These officers have the legal authority to examine navigational logs, inspect physical fishing gear, and check the onboard catch of foreign vessels to verify compliance with national fishing regulations and detect unauthorized harvesting activities.

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87. (C) National Biodiversity Authority
Under the Biological Diversity Act of 2002, foreign individuals, non-resident Indians, and foreign-controlled corporate entities are subject to strict regulatory oversight. To access Indian biological resources or associated traditional knowledge for commercial utilization or research, these entities must obtain prior written approval from the National Biodiversity Authority, ensuring sovereign control over national biodiversity assets.

88. (D) Relatively undisturbed areas that do not fall under CRZ-I or II, typically rural
Coastal Regulation Zone notifications utilize a classification system to manage developmental activities along the shoreline. CRZ-III is specifically defined to include coastal areas that are relatively undisturbed and do not fall under the ecologically sensitive CRZ-I or substantially developed urban CRZ-II categories. These areas are typically rural or semi-urban coastal zones with restricted construction.

89. (A) Sustainable economic growth with environmental conservation
The National Policy on Marine Fisheries of 2017 integrates the concept of blue growth into its governance framework. This approach focuses on balancing sustainable economic development in the marine sector with the conservation of marine and coastal ecosystems. It aims to improve human well-being and social equity

while significantly reducing environmental risks and ecological scarcities.

90. (A) I, II, IV and V
The Marine Products Export Development Authority is a statutory body established under an act of parliament in 1972. Operating under the Ministry of Commerce and Industry, the authority is responsible for promoting the export of all marine products from India and setting strict quality control standards for seafood, without holding regulatory authority over foreign military vessels.

91. (C) Minimizing environmental impact on the ecosystem
The Marine Stewardship Council uses three core principles to evaluate the sustainability of wild-capture fisheries. Principle one focuses on maintaining healthy target fish stocks. Principle two requires that fishing operations are managed to minimize their environmental impact, ensuring the structure, productivity, function, and diversity of the surrounding marine ecosystem are not severely compromised.

92. (D) Ensure traceability of catch from the point of harvest to the final market
Catch documentation schemes are critical regulatory tools used to combat illegal, unreported, and unregulated fishing. These schemes require detailed records that track marine products along the entire supply chain. By ensuring complete traceability from the point of harvest to the final consumer market, they prevent illicitly caught seafood from entering legitimate national and international trade channels.

93. (A) The EEZ and the High Seas
Under the United Nations Convention on the Law of the Sea, specific high seas freedoms are extended to other maritime zones. The freedom of navigation and overflight applies to both the high seas and the exclusive economic zone. This ensures that foreign vessels and aircraft can transit through these waters without undue restriction from adjacent coastal states.

94. (A) P-2, Q-4, R-1, S-3
International ocean governance is shaped by various agreements. The United Nations Convention on the Law of the Sea provides the primary legal framework. The United Nations Fish Stocks Agreement manages highly migratory species, while the Port State Measures Agreement targets illegal fishing by denying port access. The MARPOL Convention regulates and prevents pollution from shipping activities.

95. (D) A is false but R is true.
The FAO Code of Conduct for Responsible Fisheries does not legally penalize states for non-compliance. This is because the code is a voluntary, non-binding instrument that lacks direct legal enforcement mechanisms. It relies on voluntary adoption by governments to integrate its sustainable principles and ecosystem approaches into their respective national fisheries policies and legislations.

96. (D) Export and import permits governed by Appendices I, II, and III
The Convention on International Trade in Endangered Species of Wild Fauna and Flora regulates international trade using a permitting system. Species are categorized into three appendices based on their level of vulnerability. Lawful trade in these listed specimens requires the issuance of specific export and import permits, ensuring that trade is sustainable and does not threaten wild populations.

97. (A) Cross one or more national jurisdictional boundaries
The Convention on Migratory Species defines a migratory species based on its transboundary movements. Under this treaty, a species is considered migratory if its entire population or any geographically separate part cyclically and predictably crosses one or more national jurisdictional boundaries. This ecological behavior necessitates international cooperation among range states to ensure successful conservation.

98. (D) A is false but R is true.
Designating a wetland as a Ramsar site does not require a complete ban on human activity. The Ramsar Convention does not advocate for absolute preservation; instead, it promotes the wise-use principle, which encourages the sustainable development and utilization of wetland resources for human benefit in a way that maintains the natural ecological character of the ecosystem.

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99. (B) Ingestion and entanglement
The prohibition of plastic disposal under MARPOL Annex V is specifically aimed at protecting marine wildlife from physical hazards. Persistent plastic waste in the ocean leads to ingestion, where animals mistake debris for food, causing starvation. It also causes entanglement, where marine mammals, turtles, and seabirds become trapped in synthetic nets and lines, leading to drowning or injury.

100. (C) Zero
Following the implementation of the global moratorium on commercial whaling by the International Whaling Commission in 1986, the catch limits for all commercial whaling operations were effectively set to zero. This measure was established to halt the decline of depleted whale populations and allow stocks to recover while undergoing scientific assessment.

101. (D) Tuna and tuna-like species in the Indian Ocean
The Indian Ocean Tuna Commission is an intergovernmental organization established to manage specific pelagic resources. Its regulatory mandate is strictly limited to tuna and tuna-like species, as well as selected sharks caught in association with these fisheries, within the Indian Ocean and adjacent seas, ensuring sustainable harvesting through regional cooperation and scientific research.

102. (A) The Bay of Bengal region
The Bay of Bengal Programme Inter-Governmental Organisation operates within a specific regional context, serving coastal nations surrounding the Bay of Bengal. This includes member states such as Bangladesh, India, Maldives, and Sri Lanka. The organization facilitates regional cooperation to address shared challenges in coastal fisheries management, marine conservation, and small-scale fisher welfare.

103. (B) Externalities where individual actions negatively impact the collective resource
The economic justification for state intervention in fisheries is rooted in the concept of negative externalities. In an unregulated fishery, individual fishers do not bear the full cost of resource depletion caused by their harvesting. Their private actions impose external costs on other fishers and the ecosystem, necessitating state regulation to align private incentives with collective sustainability.

104. (C) The outermost points of the outermost islands and drying reefs
Under the United Nations Convention on the Law of the Sea, qualifying archipelagic states are permitted to draw straight archipelagic baselines. These baselines are constructed by connecting the outermost points of the outermost islands and drying reefs of the archipelago. This method defines the internal archipelagic waters over which the state exercises sovereign control.

105. (A) P-1, Q-2, R-3, S-4
Under international maritime law, jurisdictional zones are defined by specific distances from baselines. The territorial sea extends up to twelve nautical miles, while the contiguous zone extends up to twenty-four nautical miles. The exclusive economic zone is generally limited to two hundred nautical miles, and the continental shelf extends to two hundred miles or the margin's outer edge.

106. (B) The sea within one marine league of the sea coast and navigable rivers
The Indian Fisheries Act of 1897 provides a specific statutory definition of the term water to establish its geographic jurisdiction. Under this legislation, water includes the sea within one marine league of the sea coast, as well as all estuarine and navigable rivers, lakes, and other inland water bodies where fishing activities are conducted.

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107. (C) Operating mechanized bottom trawlers in territorial waters during the closed season
The monsoon trawl ban, enforced under state Marine Fishing Regulation Acts, is a spatial and temporal closure designed to protect breeding populations. Operating mechanized bottom trawlers in territorial waters during this designated closed season constitutes a major regulatory violation, as it disrupts spawning grounds and harvests vulnerable juvenile fish, undermining resource conservation efforts.

108. (D) Foreign crew must eventually be replaced by Indian crew
Guidelines governing the Letter of Permission scheme for deep-sea fishing vessels in India included specific terms to promote domestic capacity. To ensure that local fishers benefited

the harvest was sustainable and will not threaten the wild population's survival.

147. (C) Coordinated research, conservation, and mitigation of anthropogenic threats
Under the Convention on Migratory Species, regional Memorandums of Understanding for marine mammals are designed to facilitate international cooperation among range states. These administrative instruments coordinate scientific research, habitat conservation efforts, and the mitigation of human-induced threats such as ship strikes, acoustic pollution, bycatch, and marine debris across transboundary migratory pathways.

148. (B) 1%
A wetland is recognized as being of international importance under the Ramsar Convention if it meets specific biological criteria. One key criterion is whether the wetland regularly supports one percent of the individuals in a population of one species or subspecies of waterbird, highlighting the site's critical ecological role in maintaining global avian biodiversity.

149. (C) Marine plastic pollution and ghost fishing
The regulation of fishing gear disposal under MARPOL Annex V aims to protect marine ecosystems from synthetic debris. Abandoned, lost, or discarded fishing nets and lines persist in the ocean, causing marine plastic pollution. They also lead to ghost fishing, where lost gear continues to trap and kill marine mammals, fish, and turtles.

150. (D) Blue whale
The International Whaling Commission was established to regulate the harvesting of whale stocks. Its regulatory purview is strictly limited to large whale species, including baleen whales like the blue whale, fin whale, and humpback whale, as well as large toothed whales like the sperm whale, ensuring their conservation through global catch limits and sanctuaries.

151. (A) Distribute the total allowable catch among members sustainably
The Indian Ocean Tuna Commission determines catch allocations to manage shared pelagic resources in its convention area. These allocations are designed to distribute the total allowable catch sustainably among member states. By setting clear harvest limits for each nation, the commission aims to prevent overexploitation of vulnerable species like yellowfin and bigeye tuna.

152. (C) Regional advisory and capacity-building organization
The Bay of Bengal Programme Inter-Governmental Organisation functions as a regional advisory and capacity-building body. It does not possess direct regulatory or law enforcement powers. Instead, it works with member nations to provide technical advice, conduct training programs, and facilitate the sharing of best practices in small-scale fisheries management and marine conservation.

153. (B) Common-pool resources subject to subtractability
The fundamental economic premise for state intervention in fisheries is that wild fish stocks are common-pool resources. These resources are characterized by high subtractability, meaning that one fisher's catch reduces the quantity of fish available to others. Without regulatory oversight, this rivalry in consumption leads to overfishing, resource depletion, and economic rent dissipation.

154. (C) Low water line along the coast
Under the United Nations Convention on the Law of the Sea, normal baselines are used to measure the breadth of a state's territorial sea. The normal baseline is defined as the low-water line along the coast, as officially marked on large-scale charts recognized by the coastal state, providing a stable boundary for maritime claims.

155. (D) 350 nm from the baseline
Under the United Nations Convention on the Law of the Sea, if a coastal state's continental margin geologically extends beyond two hundred nautical miles, the state can claim an extended continental shelf. The treaty limits this claim to a maximum of 350 nautical miles from the baseline, or one hundred miles from the 2,500-meter isobath.

156. (A) Catch or destroy fish intentionally
The Indian Fisheries Act of 1897 includes strict prohibitions against destructive fishing methods. Section five of this historic statute outlaws the use of noxious poisons or chemical substances in any water body with the intent to catch or destroy fish, protecting aquatic life from indiscriminate

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within the exclusive economic zone is subject to coastal state regulation. Foreign nations wishing to conduct scientific surveys in this zone must obtain the prior consent of the coastal state, which is normally granted for peaceful, non-commercial research projects under specified conditions.

119. (A) Lack of full scientific certainty shall not be used as a reason for postponing conservation measures
The precautionary approach, as defined in the United Nations Fish Stocks Agreement, is a fundamental tenet of sustainable fisheries management. It dictates that where there are threats of serious or irreversible damage, a lack of full scientific certainty regarding stock status must not be used as a reason for postponing or failing to implement conservation measures.

120. (C) Aquaculture and culture-based fisheries
Article nine of the FAO Code of Conduct for Responsible Fisheries outlines specific international guidelines for aquaculture development. It urges states to establish administrative and legal frameworks that promote sustainable aquaculture, minimize environmental impacts on coastal habitats, protect genetic diversity, and ensure that farming operations do not negatively affect the livelihoods of local capture fishing communities.

121. (D) Such export will not be detrimental to the survival of the species
Under the rules of CITES, exporting an Appendix II species requires the designated scientific authority of the exporting state to make a non-detriment finding. This official assessment must scientifically verify that the proposed export of the marine or terrestrial specimens will not be detrimental to the long-term survival of the species in the wild.

122. (A) Endangered migratory species subject to strict protection
The Convention on Migratory Species protects transboundary animals by classifying them into separate appendices. Appendix I lists migratory species that are scientifically assessed as being in danger of extinction throughout all or a significant portion of their range. Range states are legally obligated to strictly protect these species, conserve their habitats, and mitigate migration obstacles.

123. (B) Changes in ecological character have occurred, are occurring, or are likely to occur
The Montreux Record is a voluntary register maintained under the Ramsar Convention on Wetlands. It lists designated wetlands of international importance where changes in ecological character have occurred, are occurring, or are highly likely to occur as a direct result of technological developments, pollution, urbanization, or other adverse human interference.

124. (A) P-1, Q-3, R-2, S-4
International environmental governance relies on specific legal instruments. The MARPOL Convention includes Annex V to regulate garbage pollution. The Ramsar Convention maintains the Montreux Record for threatened wetlands. CITES utilizes Appendices I, II, and III to control wildlife trade, and the United Nations Convention on the Law of the Sea outlines arbitration procedures under Annex VII.

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125. (B) Revised Management Procedure (RMP)
The International Whaling Commission utilizes the Revised Management Procedure to calculate sustainable catch limits for commercial whaling, should the moratorium ever be lifted. This scientifically rigorous, computer-simulated algorithm estimates allowable harvests based on historical catch data and modern population estimates, prioritizing stock conservation and preventing depletion under conditions of scientific uncertainty.

126. (C) Total catch, effort data, and size frequency data of tuna catches
The Indian Ocean Tuna Commission requires member states to comply with data reporting mandates. To support scientific stock assessments, members must regularly submit detailed fisheries data. This information must include total catch weights, nominal fishing effort records, and size frequency distributions of harvested tuna and tuna-like species across different fishing zones.

127. (C) SDG 14
The United Nations Sustainable Development Goals provide a global blueprint for a sustainable future. Among these, SDG 14 is specifically dedicated to Life Below Water. This goal outlines targets to prevent marine pollution, protect and restore coastal ecosystems, regulate harvesting to

from the offshore sector, the scheme mandated that any foreign crew employed on LOP vessels must be systematically phased out and replaced by trained Indian crew members over time.

109. (A) State Pollution Control Boards
The Environmental Protection Act of 1986 sets national standards for pollution control, but its practical enforcement is decentralized. In India, State Pollution Control Boards are the primary agencies responsible for monitoring and enforcing effluent discharge standards at the local level, ensuring that coastal aquaculture units do not release untreated, harmful wastewater into marine ecosystems.

110. (B) Reef-building corals, black corals, and fire corals
The Wildlife Protection Act of 1972 protects fragile marine habitats by listing key coral taxa under Schedule I. This category provides absolute legal protection to reef-building scleractinian corals, black antipatharian corals, organ pipe corals, and fire hydrozoan corals. Harvesting, selling, or destroying these specified formations is strictly prohibited and carries severe criminal penalties.

111. (C) Are liable to be forfeited to the Central Government
Under the Maritime Zones of India Act of 1981, unauthorized foreign vessels operating within Indian waters are subject to strict legal penalties. Upon apprehension and subsequent adjudication by designated national courts, any confiscated foreign fishing vessel, along with its physical gear and onboard catch, is liable to be officially forfeited to the central government of India.

112. (D) State Biodiversity Board
The Biological Diversity Act of 2002 distinguishes between foreign and domestic entities accessing biological resources. While foreign applicants must seek approval from the national authority, Indian citizens and domestic organizations seeking access to biological resources for commercial utilization are legally required to give prior intimation to the concerned State Biodiversity Board before collection.

113. (A) Regulating municipal waste discharge and pollution
CRZ-IV covers the marine water area extending from the low tide line up to twelve nautical miles seaward. The primary management focus within this critical zone is to regulate and control the discharge of untreated municipal sewage, industrial effluents, and other land-based pollutants, thereby preserving water quality and protecting coastal living resources.

114. (B) The empowerment of women in post-harvest processing and marketing
The National Policy on Marine Fisheries of 2017 addresses social equity by focusing on gender issues in the sector. The policy emphasizes the economic empowerment of women, who play a dominant role in post-harvest processing, preservation, and retail marketing of fish. It supports providing better infrastructure, credit access, and safety at work for women fishers.

115. (C) Upgrading processing facilities to meet international hygiene standards
The Marine Products Export Development Authority provides targeted financial assistance and subsidies to the seafood processing sector in India. These resources are primarily aimed at upgrading processing facilities, cold storage units, and peeling sheds to meet strict international hygiene and sanitary standards, thereby ensuring compliance with importing country regulations.

116. (D) The product is kept separate and traceable back to the certified fishery
Chain of custody certification is a core component of seafood ecolabeling programs. It guarantees that certified seafood is kept physically separate from uncertified products at every stage of the supply chain. This strict segregation ensures that the final retail product is fully traceable back to the specific sustainably managed capture fishery that earned the ecolabel.

117. (A) Denying port entry or use of port services to known IUU vessels
The primary enforcement mechanism of the Port State Measures Agreement is the systematic denial of port access to non-compliant ships. Port states inspect foreign vessels and, upon finding evidence of illegal fishing, deny them entry or prohibit them from landing catches, transshipping seafood, or refueling, effectively blocking illicit fish from entering the market.

118. (C) The prior consent of the coastal state
Under the United Nations Convention on the Law of the Sea, marine scientific research

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in India. Any individual or corporate entity seeking to apply for intellectual property rights for an invention based on biological resources or associated traditional knowledge obtained from India must obtain prior written approval from the National Biodiversity Authority.

138. (C) Agriculture and traditional fishing-related activities
CRZ-III designated areas consist of relatively undisturbed coastal rural zones. To balance local livelihoods with conservation, Coastal Regulation Zone notifications permit specific low-impact activities in this zone. These allowed uses include agriculture, horticulture, salt harvesting, and traditional fishing-related activities, while imposing strict limits on new commercial and industrial construction.

139. (D) Managed access and regulated entry
The National Policy on Marine Fisheries of 2017 addresses the depletion of marine resources by advocating for a shift in governance. The policy seeks to replace the existing open-access system, which leads to overfishing, with a regime of managed access and regulated entry, utilizing licensing and vessel restrictions to match fishing effort with sustainable yields.

140. (A) MPEDA
The Marine Products Export Development Authority is the primary statutory agency responsible for registering seafood processing units, cold storage facilities, and exporting entities in India. This registration process is mandatory for any facility intending to process or handle marine products for international export, ensuring compliance with global quality and food safety standards.

141. (A) Wild-capture fisheries
The Marine Stewardship Council ecolabel is a globally recognized sustainability certification. This specific program applies exclusively to wild-capture marine and freshwater fisheries. It evaluates whether the target fish stock is healthy, the fishing operations minimize environmental impacts on the wider ecosystem, and the fishery is managed under an effective, law-abiding governance system.

142. (C) Identify and penalize vessels engaged in illicit fishing activities
Regional Fisheries Management Organizations maintain updated lists of vessels identified as having engaged in illegal, unreported, and unregulated fishing. This IUU vessel list serves as a key enforcement tool, helping member nations identify illicit operators, deny them port entry, confiscate their catches, and restrict them from receiving official fishing authorizations or subsidies.

143. (D) International Tribunal for the Law of the Sea (ITLOS))
The International Tribunal for the Law of the Sea is an independent judicial body established by the United Nations Convention on the Law of the Sea. It has jurisdiction over disputes concerning the interpretation or application of the convention, including conflicts related to marine fisheries, resource conservation, and boundaries in the exclusive economic zone.

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144. (A) The best scientific evidence available
The United Nations Fish Stocks Agreement requires member states of Regional Fisheries Management Organizations to establish conservation and management measures for straddling and highly migratory species. The agreement mandates that these measures be based on the best scientific evidence available, ensuring that harvest quotas and gear regulations are grounded in objective biological assessments.

145. (C) Bycatch, habitat impacts, and trophic interactions
The ecosystem approach to fisheries differs from traditional single-species management by incorporating a broader range of ecological factors. It explicitly considers the impacts of fishing on non-target species through bycatch, the physical damage inflicted on benthic marine habitats, and the wider consequences of resource extraction on trophic food webs and ecosystem productivity.

146. (A) An export permit from the country of origin
Under the international regulations of CITES, commercial shipments of species listed in Appendix II must be accompanied by a valid export permit. This permit is issued by the management authority of the exporting country only after their scientific authority confirms that

166. (C) Destructive fishing practices like poisons or explosives
To achieve or maintain sustainability certification under the Marine Stewardship Council standard, a fishery must comply with strict operational rules. The standard prohibits the use of highly destructive fishing practices, such as poisons, chemical substances, or explosives to harvest fish. These destructive methods cause indiscriminate mortality and lead to irreversible habitat damage.

167. (B) Deny IUU vessels access to lucrative global markets and services through port restrictions
Port state measures are highly effective in combating illegal, unreported, and unregulated fishing by creating economic barriers. By denying non-compliant vessels entry to ports or restricting access to services like refueling, repairs, and landing catches, these measures prevent IUU fishers from selling their illegal catches, making their operations economically unviable.

168. (A) The flag state under whose registry the vessel operates
Under the United Nations Convention on the Law of the Sea, the principle of flag state jurisdiction governs vessels on the high seas. This means that the state under whose registry a vessel operates has exclusive jurisdiction and regulatory control over that vessel, including its crew, safety standards, and fishing activities in international waters.

169. (C) The EEZ and the adjacent high seas for straddling stocks
The United Nations Fish Stocks Agreement requires that conservation and management measures established for straddling fish stocks be compatible across jurisdictions. This means that measures implemented within a coastal state's exclusive economic zone must be aligned with those adopted for the adjacent high seas, ensuring cohesive, science-based conservation throughout the species' range.

170. (A) Food safety, quality, and minimizing post-harvest losses
Article eleven of the FAO Code of Conduct for Responsible Fisheries addresses post-harvest practices and responsible international trade. It outlines guidelines for ensuring seafood safety and quality, minimizing post-harvest physical and nutritional losses, and promoting fair trade practices that do not lead to environmental degradation or undermine the food security of local communities.

171. (C) Scientific research or conservation breeding
Under CITES, species listed in Appendix I are subject to strict trade bans. International trade in these endangered specimens is permitted only under exceptional, non-commercial circumstances. These allowed uses include scientific research, conservation breeding programs, or educational exhibits, provided that both exporting and importing state authorities issue the necessary CITES permits.

172. (B) States that exercise jurisdiction over any part of the range of a migratory species
The Convention on Migratory Species defines a range state as any nation that exercises sovereign jurisdiction over any part of the geographic range of a migratory species. This includes territories where the species breeds, feeds, rests, or transits, obligating these states to cooperate in conserving the species across its entire transboundary pathway.

173. (C) Sustainable development
The Ramsar Convention's concept of wise use is defined as the maintenance of wetland ecological character through the implementation of ecosystem approaches. This concept is equated with sustainable development, allowing human communities to utilize wetland resources for economic benefit in a way that does not compromise the long-term biological functionality of the ecosystem.

174. (D) Discharges and disposals of garbage, including fishing gear
Under MARPOL Annex V, ships above a certain tonnage must maintain an official Garbage Record Book. This log is used to systematically track and record all discharges and disposals of garbage, including accidental losses of synthetic fishing gear. This record-keeping requirement helps port authorities monitor compliance and prevent plastic pollution in the oceans.

175. (A) Address cultural and nutritional needs of indigenous peoples based on scientific advice
The International Whaling Commission provides specific exemptions to its commercial whaling moratorium for aboriginal subsistence whaling. This allowance is designed to address the cultural

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mortality and preventing the contamination of local water supplies.

157. (B) Ensure safety, regulate fishing effort, and monitor catches
State Marine Fishing Regulation Acts require all mechanized fishing vessels to be officially registered with state authorities. This administrative measure is designed to ensure safety at sea, regulate overall fishing effort by limiting fleet capacity, and monitor marine catches, helping fisheries managers implement effective conservation plans and detect illegal fishing activities.

158. (C) Joint ventures and chartering of foreign deep-sea fishing vessels
The Murari Committee of 1995 reviewed India's deep-sea fishing policies following protests by coastal fishers. The committee recommended the immediate cancellation of licenses and the phasing out of all joint ventures, joint chartering arrangements, and lease schemes involving foreign deep-sea fishing vessels, aiming to protect domestic fishers and conserve marine resources in the exclusive economic zone.

159. (D) Ecologically sensitive areas and marine biodiversity
The Environmental Protection Act of 1986 empowers the central government to restrict industrial operations and development in coastal zones. These regulatory measures are designed to protect ecologically sensitive areas, such as mangroves, estuaries, and coral reefs, from habitat destruction and pollution, thereby conserving marine biodiversity and maintaining critical coastal nursery grounds.

160. (A) Olive Ridley sea turtle
The olive ridley sea turtle is a marine reptile that nests in large numbers along the eastern coast of India. To protect this species from threats like bycatch and nesting habitat destruction, it is listed under Schedule I of the Wildlife Protection Act of 1972, granting it the highest level of legal protection in India.

161. (B) Adhere to license conditions regarding specified fishing zones, gear, and catch quotas
Foreign fishing vessels permitted to operate within the Indian exclusive economic zone under the MZI Act of 1981 are subject to strict regulatory conditions. These vessels must adhere to their license terms, which specify permitted fishing zones, restricted gear types, and catch quotas, preventing unauthorized harvesting and protecting sovereign marine resources from overexploitation.

162. (C) Local self-government (Panchayat/ Municipality)
The Biological Diversity Act of 2002 mandates a decentralized approach to biodiversity conservation in India. Under the act, every local self-government body, including panchayats and municipalities, must establish a Biodiversity Management Committee. These local committees are responsible for promoting conservation, documenting traditional knowledge, and compiling People's Biodiversity Registers within their jurisdictions.

163. (D) Managing areas substantially built-up with infrastructure close to the shoreline
Coastal Regulation Zone notifications categorize the coastal environment into distinct zones. CRZ-II is designated specifically for coastal areas that are already substantially built-up with municipal infrastructure, roads, and residential buildings close to the shoreline. Management in this zone focuses on regulating new construction and rebuilding to prevent environmental hazards.

164. (A) Protecting spawning stocks and juvenile fish
The National Policy on Marine Fisheries of 2017 supports the use of spatial and temporal closures as key conservation tools. These measures, which include seasonal fishing bans and marine protected areas, are implemented to protect spawning fish stocks during their breeding seasons and safeguard juvenile fish in nearshore nursery grounds from destructive harvesting.

165. (B) Establishing cold storage and fish markets
The National Fisheries Development Board provides targeted financial assistance for various post-harvest development activities in India. This support includes funding for establishing modern cold storage facilities, ice plants, refrigerated transport, and hygienic fish retail markets. These initiatives aim to reduce post-harvest losses, improve seafood quality, and ensure better prices for local fishers.

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end overfishing, and increase scientific knowledge to enhance ocean health.

128. (A) Both A and R are true and R is the correct explanation of A.
Overcapitalization in fisheries is a direct economic consequence of open-access regimes. Because entry is unrestricted, individual fishers invest heavily in larger vessels and advanced gear to catch fish before others do. They ignore the negative externalities their increased effort imposes on the shared stock, resulting in excessive fleet capacity and severe biological overexploitation.

129. (B) Customs, fiscal, immigration, or sanitary laws
Under the United Nations Convention on the Law of the Sea, the contiguous zone serves as an enforcement buffer adjacent to the territorial sea. Within this twenty-four-mile zone, the coastal state possesses the administrative authority to prevent and punish infringements of its specific customs, fiscal, immigration, or sanitary laws committed within its territory or territorial sea.

130. (C) Absolute sovereignty over the airspace above the EEZ for restricting foreign commercial flights
Sovereign rights exercised by a coastal state within its exclusive economic zone are specifically limited to economic exploration and resource management. They do not extend to absolute territorial sovereignty over the superjacent airspace. Consequently, foreign commercial and military aircraft retain the international freedom of overflight through the airspace above a state's exclusive economic zone.

131. (D) Discharging dynamite to catch fish in navigable rivers
The Indian Fisheries Act of 1897 was enacted to protect aquatic resources from destructive harvesting practices. Under this statute, discharging dynamite or other explosives into navigable rivers, estuaries, or coastal waters to catch or destroy fish is classified as a serious offense, carrying penalties of fines and potential imprisonment for violators.

132. (A) Imposing minimum mesh size limits for trawl cod ends
State Marine Fishing Regulation Acts allow state governments to implement technical measures to conserve marine resources. A primary gear regulation under these acts is the imposition of minimum mesh size limits for trawl cod ends. This regulation allows juvenile fish to escape, reducing growth overfishing and supporting the recruitment of wild marine populations.

133. (B) Safeguarding the interests of the domestic fishing industry and traditional fishers
The transition from India's 1991 Deep Sea Fishing Policy to the recommendations of the Murari Committee in 1995 marked a major shift in national fisheries governance. It redirected policy focus away from foreign joint ventures toward safeguarding the economic interests of the domestic fishing industry and protecting the traditional livelihoods of small-scale coastal fishers.

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134. (B) Bioaccumulate in aquatic food webs
Effluent regulations under the Environmental Protection Act of 1986 strictly control the discharge of heavy metals into coastal waters. These chemical substances pose severe ecological threats because they persist in the environment and bioaccumulate in aquatic food webs. This bioaccumulation presents health risks to marine organisms and poses toxicological hazards to human seafood consumers.

135. (D) Schedule I
Sea cucumbers play a vital role in recycling nutrients in marine benthic ecosystems. Due to intense illegal harvesting driven by international demand, these echinoderms have been granted the highest level of legal protection in India. They are listed under Schedule I of the Wildlife Protection Act of 1972, making their collection or trade illegal.

136. (A) Confiscation of the vessel, gear, and catch, along with substantial fines
The Maritime Zones of India Act of 1981 establishes severe penalties for foreign vessels caught fishing without authorization within India's exclusive economic zone. Convicted operators face the mandatory confiscation of their fishing vessel, onboard gear, and harvested catch. In addition, the courts can impose substantial monetary fines on the vessel's master and owners.

137. (B) National Biodiversity Authority
The Biological Diversity Act of 2002 regulates the commercialization of biological resources

and nutritional needs of indigenous communities, such as those in Alaska, Greenland, and Siberia, provided that the catch limits are based on scientific advice and do not threaten stock recovery.

176. (B) Measures to reduce bycatch of sea turtles and seabirds in longline fisheries
The Indian Ocean Tuna Commission has adopted specific binding resolutions to mitigate the ecological impacts of pelagic fishing. These include measures designed to reduce the accidental bycatch of non-target species, such as marine turtles and seabirds, in longline fisheries. The resolutions mandate the use of circle hooks, turtle de-hookers, and bird-scaring lines.

177. (C) Improve the socio-economic conditions of small-scale fisherfolk in the Bay of Bengal
The core objective of the Bay of Bengal Programme Inter-Governmental Organisation is to improve the socio-economic conditions of small-scale and artisanal fisherfolk in its member nations. The organization achieves this by promoting sustainable fisheries management, encouraging the adoption of safe and eco-friendly technologies, and supporting community-based conservation initiatives around the bay.

178. (B) Total revenue equals total costs, dissipating resource rent
In fisheries economics, unregulated open-access fisheries tend to reach a bionomic equilibrium where total revenue equals total costs. Because entry is unrestricted, vessels continue to join the fishery as long as there is economic profit. This entry of effort continues until all resource rent is dissipated, leaving fishers with zero net economic profit.

179. (C) Straight baselines connecting appropriate points
Under the United Nations Convention on the Law of the Sea, if a coastline is deeply indented or has a fringe of islands in its immediate vicinity, a coastal state can draw straight baselines. These baselines connect appropriate points along the coast, separating internal landward waters from the seaward territorial sea and other maritime zones.

180. (D) Baseline
The exclusive economic zone is a maritime zone where a coastal state exercises specific sovereign rights over natural resources. Under the United Nations Convention on the Law of the Sea, the maximum breadth of this zone is two hundred nautical miles, which is measured seaward exclusively from the baseline from which the territorial sea is measured.

181. (A) A person commits an offense under section 4 (explosives) or section 5 (poisons))
The Indian Fisheries Act of 1897 provides enforcement officers with specific powers to address destructive fishing. Under section seven of this statute, police officers may arrest any person without a warrant if they are found committing an offense under section four, involving explosives, or section five, involving the use of poisons to destroy fish.

182. (B) Assign specific distances from the shore for different classes of fishing vessels
State Marine Fishing Regulation Acts utilize spatial zonation as a key management tool. This feature involves assigning specific distances from the shoreline for different classes of fishing vessels. Nearshore waters are typically reserved for traditional, non-mechanized craft, while larger mechanized vessels are restricted to deeper offshore waters, reducing conflicts and protecting coastal habitats.

183. (C) Allowing foreign vessels to fish without adequate local benefit or regulatory control
The Letter of Permission scheme in India's deep-sea fisheries sector faced significant criticism from domestic fishers and conservationists. Critics argued that the scheme allowed foreign-owned and operated vessels to fish in the exclusive economic zone under the guise of Indian joint ventures, without providing significant economic benefits to local communities or ensuring adequate regulatory oversight.

184. (D) Coastal Regulation Zone (CRZ) Notifications
The Environmental Protection Act of 1986 provides the legal basis for managing coastal development in India. The central government uses Coastal Regulation Zone notifications as the primary mechanism to enforce compliance. These notifications classify the coastal stretch into distinct zones, regulating land use, industrial development, and aquaculture activities to protect fragile marine ecosystems.

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203. (D) Individual Transferable Quotas (ITQs))
State intervention can address the Tragedy of the Commons by defining and assigning clear access rights to fishers. Individual Transferable Quotas are an effective management tool that allocates a specific share of the total allowable catch to individual fishers or vessels. These quotas can be traded, giving fishers a secure economic interest in resource conservation.

204. (A) Internal Waters
Under the United Nations Convention on the Law of the Sea, waters situated on the landward side of the baseline from which the territorial sea is measured are classified as internal waters. The coastal state exercises full territorial sovereignty over these internal waters, which include estuaries, bays, ports, and navigable rivers, as if they were land territory.

205. (B) Mineral and non-living resources, plus sedentary living organisms
Under the United Nations Convention on the Law of the Sea, a coastal state exercises specific sovereign rights over its continental shelf. These rights are limited to the exploration and exploitation of non-living resources, such as oil, natural gas, and minerals in the subsoil, as well as sedentary living organisms that remain attached to the seabed.

206. (B) 2 years
The Indian Fisheries Act of 1897 delegates legislative power to state governments to manage aquatic resources within their jurisdictions. Under section six of this statute, states are authorized to frame rules that prohibit fishing in specified waters for a conservation period not exceeding two years, allowing depleted local fish stocks to recover.

207. (C) Safeguard small-scale traditional fishers and protect shallow coastal nursery grounds
Restricting mechanized bottom trawlers from operating in shallow coastal waters is a key management measure under state regulations. This spatial restriction is designed to protect nearshore marine habitats, which serve as critical spawning and nursery grounds for many fish species. It also safeguards the livelihoods of traditional, artisanal fishers who depend on these shallow areas.

208. (D) AIS and VMS (Vessel Monitoring Systems))
To ensure effective regulatory oversight of the deep-sea sector, guidelines governing the Letter of Permission scheme in India required vessels to carry modern monitoring technology. LOP vessels were mandated to install Automatic Identification Systems and Vessel Monitoring Systems, allowing national enforcement agencies to track vessel positions in real-time and prevent unauthorized nearshore fishing.

209. (A) Strictly regulated and penalized if standards are breached
Under the Environmental Protection Act of 1986, discharging untreated wastewater from coastal aquaculture farms into public marine and estuarine water bodies is strictly regulated. Operators must treat their effluents to comply with national environmental standards. Failure to meet these quality limits can result in legal penalties, fines, and the closure of the aquaculture facility.

210. (B) Pondicherry shark (Carcharhinus hemiodon))
The Pondicherry shark is an extremely rare and critically endangered elasmobranch species found in Indian waters. To protect this shark from extinction, it is granted the highest level of legal protection in India by being listed under Schedule I of the Wildlife Protection Act of 1972, which prohibits its hunting, capture, or commercial trade.

211. (C) A valid license or permit issued by the Central Government
Under the Maritime Zones of India Act of 1981, any foreign vessel intending to engage in commercial fishing operations within India's exclusive economic zone must carry a mandatory legal document. This document is a valid fishing license or permit issued directly by the central government, ensuring sovereign control over national marine resources.

212. (D) Local communities and vaids/hakims using bio-resources for traditional practices
The Biological Diversity Act of 2002 includes specific exemptions to support traditional livelihoods in India. The act's regulatory requirements do not apply to local communities, traditional growers, or indigenous healers like vaids and hakims who access local biological resources for self-use or traditional medicinal

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194. (C) Stock information is uncertain, unreliable, or inadequate
The United Nations Fish Stocks Agreement requires states to apply the precautionary approach when managing straddling and highly migratory species. This approach is particularly critical when available stock information is uncertain, unreliable, or inadequate. In such cases, fisheries managers must set cautious harvest limits to prevent overexploitation and support stock conservation while data are collected.

195. (A) Sound scientific basis and data collection for conservation and management
Article twelve of the FAO Code of Conduct for Responsible Fisheries outlines guidelines for fisheries research. It emphasizes that sustainable conservation and management decisions must be based on a sound scientific foundation. The article urges states to support scientific data collection, biological research, and socio-economic studies to guide effective fisheries management plans.

196. (C) Scientific evidence showing the species is now threatened with extinction
Transferring a species from Appendix II to Appendix I under CITES represents an increase in its conservation protection. This administrative change requires the submission of robust scientific evidence to the Conference of the Parties, demonstrating that the species' population has declined significantly and is now threatened with extinction due to the pressures of international trade.

197. (B) Ocean noise, bycatch, and marine debris
The Convention on Migratory Species addresses various human-induced threats that impact transboundary animals. For marine migratory species like cetaceans, turtles, and sharks, the convention focuses on mitigating modern anthropogenic hazards. These threats include underwater ocean noise from shipping, accidental bycatch in commercial fisheries, and the ingestion of marine debris and plastic waste.

198. (C) IUCN
The Ramsar Convention on Wetlands is an independent intergovernmental treaty, but its administrative operations are supported by established environmental bodies. The secretariat of the convention is hosted by the International Union for Conservation of Nature in Gland, Switzerland, facilitating cooperation and sharing administrative resources to support global wetland conservation efforts.

199. (D) Adequate reception facilities for garbage from ships
To ensure the effective implementation of MARPOL Annex V, port states have specific obligations. They are required to provide adequate reception facilities at ports and terminals to collect garbage and discarded fishing gear from visiting vessels. This service allows ship crews to dispose of waste legally, reducing the likelihood of plastic dumping at sea.

200. (A) Advising on the status of whale stocks and catch limits
The scientific committee of the International Whaling Commission plays a key role in global whale conservation. This body is responsible for conducting scientific assessments of whale populations, evaluating the impacts of human activities on cetaceans, and advising the commission on stock status, sustainable catch limits, and the effectiveness of established whale sanctuaries.

201. (B) Submission of national reports and compliance committee reviews
The Indian Ocean Tuna Commission monitors compliance with its binding resolutions through established administrative procedures. Member states are required to submit detailed national reports on their fishing activities and implementation measures. These submissions are systematically reviewed by the commission's compliance committee, which identifies gaps and recommends corrective actions to ensure regional cooperation.

202. (C) Regional workshops, training programs, and policy harmonization
The Bay of Bengal Programme Inter-Governmental Organisation achieves its capacity-building and resource management goals through cooperative regional initiatives. The organization conducts technical workshops, coordinates training programs for local fisheries officers, and facilitates policy harmonization among member states around the bay, helping communities implement sustainable practices and improve coastal livelihoods.

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compliant foreign vessels within Indian waters include officers from the Indian Coast Guard and the federal Customs Department, ensuring maritime security.

262. (B) National Biodiversity Authority
Under the Biological Diversity Act of 2002, Indian researchers are subject to regulatory oversight when collaborating internationally. The act specifies that no person can transfer the results of research on Indian biological resources or associated traditional knowledge to a non-citizen or foreign entity without obtaining prior written approval from the National Biodiversity Authority.

263. (B) Mangroves, coral reefs, and sand dunes
CRZ-I contains ecologically sensitive coastal zones that are critical for maintaining marine biodiversity and protecting shores from erosion. The boundaries of this zone are defined to protect fragile coastal ecosystems, such as mangrove forests, coral reefs, sand dunes, turtle nesting beaches, and national parks, from developmental and industrial encroachment.

264. (B) Growth overfishing by restricting the capture of juveniles
The National Policy on Marine Fisheries of 2017 supports the implementation of Minimum Legal Size regulations for commercial fish species. This management tool is designed to prevent growth overfishing by restricting the harvest, landing, and sale of juvenile fish, ensuring that individuals can mature and reproduce before they are captured.

265. (B) Modern fish markets and hygienic retail outlets
The National Fisheries Development Board provides financial assistance and subsidies to modernize the domestic fisheries sector. A key focus of these funding schemes is the development of modern, hygienic fish retail markets, cold storage facilities, and ice plants, helping reduce post-harvest spoilage and improve seafood quality for consumers.

266. (B) Management system that respects local, national, and international laws
Principle three of the Marine Stewardship Council standard evaluates the governance of a capture fishery. It requires the fishery to operate under an effective management system that respects local, national, and international laws, incorporates a clear decision-making framework, and respects the rights of people dependent on the fishery for their livelihoods.

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267. (B) Exclusive Economic Zone and Continental Shelf
Under the United Nations Convention on the Law of the Sea, a coastal state has specific jurisdictional rights beyond its territorial sea. The coastal state has the exclusive right to construct, authorize, and regulate the operation of artificial islands, installations, and structures within its exclusive economic zone and on its continental shelf.

268. (B) Surplus of the allowable catch
Under the United Nations Convention on the Law of the Sea, a coastal state must determine its capacity to harvest the living resources of its exclusive economic zone. If the state does not have the capacity to harvest the entire allowable catch, it is obligated to grant other nations access to the remaining surplus.

269. (B) Apply the conservation measures established by that RFMO or not fish for the resource
The United Nations Fish Stocks Agreement addresses the role of non-members in international fisheries management. Under the agreement, if a state is not a member of a relevant Regional Fisheries Management Organization, it must still apply the conservation measures established by that organization, or refrain from fishing for those shared resources entirely.

270. (B) Transparent and inclusive of all stakeholders
The FAO Code of Conduct for Responsible Fisheries outlines international standards for sustainable fisheries management. The code encourages states to ensure that their national fisheries policies and decision-making processes are transparent and inclusive of all stakeholders, including small-scale fishers, indigenous communities, the processing industry, and environmental organizations.

271. (B) Export permit issued by the Management Authority of the exporting state
Under CITES regulations, species listed in Appendix II are subject to international trade controls to prevent overexploitation. Lawful international trade in these specimens requires the prior issuance of an export permit by the

practices, ensuring that local heritage and domestic consumption are protected.

213. (A) Traditional and improved traditional systems in specific zones with approvals
Coastal Regulation Zone notifications regulate aquaculture operations to protect the coastal environment from degradation. Under these rules, intensive industrial aquaculture is restricted, and generally, only traditional or improved traditional farming systems are permitted within specified coastal zones. These allowed operations must obtain prior environmental clearances and comply with strict waste discharge standards.

214. (B) UNCLOS and the FAO CCRF
The National Policy on Marine Fisheries of 2017 is designed to align India's national fisheries governance with international standards. The policy explicitly adopts the principles and legal frameworks established by the United Nations Convention on the Law of the Sea and the guidelines of the FAO Code of Conduct for Responsible Fisheries to promote sustainable development.

215. (C) Ministry of Fisheries, Animal Husbandry and Dairying
The National Fisheries Development Board is a statutory body established to promote the fisheries sector in India. The board operates under the administrative control of the Ministry of Fisheries, Animal Husbandry and Dairying. This alignment ensures that national funding and capacity-building programs are coordinated with broader agricultural and rural development goals.

216. (D) Marine ecosystem structure, productivity, function, and diversity
Principle two of the Marine Stewardship Council standard evaluates the ecological footprint of a capture fishery. It assesses whether fishing operations are managed to minimize their impact on the wider marine environment, ensuring that the physical structure, biological productivity, natural function, and biodiversity of the surrounding ecosystem are not severely or irreversibly compromised.

217. (A) Refuse port entry or prohibit landing, transshipping, and processing of fish
Under the Port State Measures Agreement, if a port state has clear evidence that a foreign vessel has engaged in illegal, unreported, and unregulated fishing, it must take immediate enforcement action. The port state is obligated to refuse the vessel entry to its ports or prohibit it from landing, transshipping, packaging, or processing its seafood catch.

218. (C) Participate on an equitable basis in the surplus living resources of subregional EEZs
The United Nations Convention on the Law of the Sea addresses the rights of landlocked states regarding marine resources. Under the treaty, landlocked nations have the right to participate, on an equitable basis, in exploiting the surplus portion of the allowable catch of living resources within the exclusive economic zones of coastal states in the same subregion.

219. (A) High seas and areas under national jurisdiction
The United Nations Fish Stocks Agreement contains provisions designed to protect marine biodiversity from the impacts of fishing. The agreement emphasizes that states must protect biodiversity in both the high seas and areas under national jurisdiction, such as exclusive economic zones, by implementing selective fishing methods and minimizing impacts on non-target species and habitats.

220. (C) Minimizing waste, discards, and catch of non-target species
Article eight of the FAO Code of Conduct for Responsible Fisheries outlines guidelines for fishing operations. It stresses that states must ensure harvesting is conducted in a responsible manner. This includes adopting selective fishing gears, minimizing waste and discards of commercial species, and reducing the accidental catch of non-target marine organisms and wildlife.

221. (D) CITES
Seahorses, belonging to the genus Hippocampus, are vulnerable marine fish heavily traded for traditional medicine and the aquarium market. To prevent their overexploitation, all seahorse species are listed under Appendix II of CITES, making this convention the most direct international agreement regulating their global trade through mandatory export and import permitting systems.

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222. (A) A non-legally binding administrative arrangement focusing on cooperative action
Under the Convention on Migratory Species, there is a legal distinction between different instruments. A binding Agreement is a formal treaty under international law. In contrast, a Memorandum of Understanding is a non-legally binding administrative arrangement that allows range states to collaborate on research, habitat restoration, and conservation actions for shared transboundary species.

223. (B) Provides standard data on the ecological character of a designated Ramsar site
The Ramsar Information Sheet is a standardized administrative document required for every designated wetland of international importance. It provides comprehensive scientific data on the site's ecological character, dominant plant and animal species, hydrological functions, and current conservation status, helping the Ramsar Secretariat and national governments monitor environmental changes and manage the wetland sustainably.

224. (C) Under no condition, except accidental loss where all reasonable precautions were taken
Under MARPOL Annex V, the discharge of plastics, including synthetic ropes, fishing nets, and garbage bags, into the ocean is strictly prohibited. Fishing vessels are not exempt from this rule, except in cases of accidental loss of fishing gear where all reasonable precautions were taken, or to secure the safety of the ship and crew.

225. (D) Large whale species targeted commercially
The International Whaling Commission's commercial whaling moratorium, implemented in 1986, is a key conservation measure. This temporary ban on commercial harvesting applies specifically to large whale species, including baleen whales like the blue, humpback, and minke whales, as well as the sperm whale, which were historically depleted by intensive industrial whaling operations.

226. (A) Managing bycatch associated with tuna fisheries
The Indian Ocean Tuna Commission is responsible for managing tuna and tuna-like species in its convention area. A key aspect of this mandate is managing the ecological impacts of pelagic fishing, which includes implementing measures to reduce the accidental bycatch of non-target species like sharks, marine turtles, and seabirds caught in association with tuna fisheries.

227. (B) Coastal environmental degradation and community livelihoods
The Bay of Bengal Programme Inter-Governmental Organisation adopts an ecosystem approach to fisheries management. This approach focuses on the links between fisheries governance, coastal environmental degradation, and the livelihoods of small-scale fishing communities. By addressing habitat loss, pollution, and climate change, the organization helps coastal populations build economic resilience and protect marine resources.

228. (B) A regulated common property resource
State intervention using licensing systems limits the number of vessels and fishers in a fishery. This regulatory measure transforms the resource from open access, where anyone can fish, into a regulated common property resource. This restriction helps control total fishing effort, reduces the competitive race to fish, and supports long-term stock sustainability.

229. (C) High seas or EEZ
Under the United Nations Convention on the Law of the Sea, archipelagic states can draw straight archipelagic baselines to define their territory. However, the treaty places specific limits on this practice. An archipelagic baseline cannot be drawn in a way that cuts off the territorial sea of another state from the high seas or its exclusive economic zone.

230. (D) Airspace above the zone
Within the contiguous zone, a coastal state does not exercise full territorial sovereignty. Its jurisdiction is limited to preventing and punishing infringements of its customs, fiscal, immigration, and sanitary laws. Consequently, the state does not have sovereign rights over the airspace above the contiguous zone, and foreign aircraft enjoy the international freedom of overflight.

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231. (A) Internal waters and the territorial sea
The Indian Fisheries Act of 1897 was enacted before the establishment of modern international maritime zones. Consequently, its geographic jurisdiction applies primarily to internal waters, such as navigable rivers, lakes, and estuaries, as well as coastal territorial waters within one marine league of the shoreline, rather than the offshore exclusive economic zone.

232. (B) Confiscation of the illegal gear and imposition of fines
Violations of technical regulations, such as cod-end mesh size limits, under state Marine Fishing Regulation Acts carry specific administrative penalties. Enforcement officers are authorized to confiscate the non-compliant fishing gear, and courts can impose monetary fines on the vessel owner and master, helping deter destructive harvesting and protect juvenile fish populations.

233. (A) The National Fishworkers Forum against foreign deep-sea vessels
The Murari Committee was appointed in India following intense protests along the coast. These demonstrations were organized by the National Fishworkers Forum and other domestic fisher associations against the central government's deep-sea fishing policies, which allowed foreign joint-venture vessels to fish in the exclusive economic zone, threatening the livelihoods of artisanal fishers.

234. (B) 1974
The Water (Prevention and Control of Pollution) Act is a key environmental statute in India. Enacted in 1974, the legislation was designed to prevent and control water pollution and maintain or restore the wholesomeness of water bodies. It established central and state pollution control boards to monitor discharges and enforce industrial effluent standards.

235. (B) Listed under Schedule I of the Wildlife (Protection) Act (1972))
The giant grouper is a large coral reef fish species found in Indian waters. Due to its vulnerability to overfishing and habitat degradation, this marine teleost has been granted the highest level of legal protection in India. It is listed under Schedule I of the Wildlife Protection Act of 1972, prohibiting its harvest or trade.

236. (A) Issuing a notification in the Official Gazette Under the Maritime Zones of India Act of 1981, the central government has the authority to define the limits and coordinates of the exclusive economic zone. To do so, the government must issue an official notification in the Gazette of India, providing legal clarity regarding the boundaries of national maritime jurisdiction under international law.

237. (B) National Biodiversity Authority in consultation with local BMCs
Under the Biological Diversity Act of 2002, the benefit-sharing formula for the commercial utilization of biological resources is determined by the National Biodiversity Authority. The authority is required to consult with local Biodiversity Management Committees to ensure that the economic benefits are shared equitably with the communities that conserve and manage those resources.

238. (C) Coastal Zone Management Authority (State/National))
To ensure compliance with Coastal Regulation Zone notifications, developmental and industrial activities within coastal stretches require prior environmental clearance. These clearances are evaluated and granted by State and National Coastal Zone Management Authorities, which assess the ecological impacts of proposed projects to protect fragile coastal ecosystems from degradation.

239. (D) Enhance coastal fishery resources and livelihoods
The National Policy on Marine Fisheries of 2017 supports the deployment of Artificial Reefs and fish aggregating devices in coastal waters. These structures are designed to enhance local marine habitats, provide shelter for fish populations, and aggregate pelagic resources, helping small-scale artisanal fishers improve their catches and support sustainable coastal livelihoods.

240. (A) Catch certification schemes for EU compliance
The Marine Products Export Development Authority is the nodal agency in India for establishing export traceability mechanisms. To comply with the European Union's IUU regulations, the authority manages catch certification schemes, verifying that seafood products exported from India to European markets were caught legally and in compliance with established conservation rules.

241. (B) Obtain or retain the MSC ecolabel for its products
To achieve or maintain sustainability certification under the Marine Stewardship Council standard, a fishery must meet all three core principles. If a fishery fails to meet Principle One, which requires maintaining healthy target fish stocks,

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185. (A) Critically threatened marine elasmobranchs
All species of sawfish, belonging to the family Pristidae, are critically threatened marine elasmobranchs whose populations have declined due to habitat loss and bycatch. To protect these vulnerable fish, they are listed under Schedule I of the Wildlife Protection Act of 1972, which prohibits their hunting, possession, or commercial trade in India.

186. (B) Indian fishing vessels
The Maritime Zones of India Act of 1981 establishes distinct legal frameworks for managing maritime activities. The legislation clearly distinguishes between foreign fishing vessels, which require specific central government permits to operate in the exclusive economic zone, and Indian fishing vessels, which are subject to domestic state regulations and licensing requirements, protecting local fishing rights.

187. (C) Document traditional knowledge and local biological resources
Under the Biological Diversity Act of 2002, Biodiversity Management Committees are mandated to compile People's Biodiversity Registers at the local level. These registers are designed to document comprehensive information on local biological resources, their medicinal or commercial uses, and the associated traditional knowledge of the community, protecting intellectual property and preventing biopiracy.

188. (D) Setting up new industries and disposal of hazardous substances
While Coastal Regulation Zone notifications categorize the coastline to regulate specific activities, certain high-impact actions are prohibited across all CRZ zones. These prohibited activities include setting up new industrial facilities, expanding existing hazardous industries, and disposing of untreated wastes or hazardous substances, preventing severe chemical pollution and protecting vulnerable marine habitats.

189. (A) Exploit deep-sea and oceanic resources sustainably
The National Policy on Marine Fisheries of 2017 supports the modernization of India's fishing fleet. This initiative is designed to encourage domestic fishers to expand their operations into deeper, offshore waters. By upgrading vessels with modern safety, navigation, and selective harvesting gear, the policy aims to exploit underutilized deep-sea and oceanic resources sustainably.

190. (B) Marine products intended for export and the premises where they are processed
The Marine Products Export Development Authority Act of 1972 grants the authority specific powers to ensure quality control. Designated officers have the legal right to inspect marine products intended for international export, as well as the processing plants, cold storages, and transport vehicles where these seafood products are handled, ensuring compliance with global food safety standards.

191. (C) The FAO Code of Conduct for Responsible Fisheries guidelines
The Marine Stewardship Council's sustainability standards for wild-capture fisheries are grounded in international best practices. These standards are developed in alignment with the guidelines of the FAO Code of Conduct for Responsible Fisheries. This ensures that the MSC evaluation process is scientifically rigorous, globally applicable, and focused on maintaining healthy fish stocks and marine ecosystems.

192. (D) A standardized catch certificate validated by the flag state
The European Union IUU Regulation is a powerful trade tool designed to prevent illegal seafood from entering the EU market. The regulation mandates that all imports of wild-caught fish must be accompanied by a standardized catch certificate. This certificate must be formally validated by the competent authority of the catching vessel's flag state, ensuring legal harvest.

193. (A) Territorial Sea
Under the United Nations Convention on the Law of the Sea, the right of innocent passage is an international navigation right. This right allows foreign vessels, including commercial and military ships, to transit through a coastal state's territorial sea without prior authorization, provided their passage is continuous, expeditious, and not prejudicial to the peace or security of the state.

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are legally obligated to implement binding conservation resolutions. These measures must be translated into national legislation within the specific timeframe stipulated in the text of the resolution, which is usually 120 days after the commission notifies members of its adoption.

252. (B) Vulnerable coastal fishing communities
The Bay of Bengal Programme Inter-Governmental Organisation implements targeted projects to address the impacts of climate change in its convention area. These initiatives focus on building climate resilience and supporting adaptation strategies for vulnerable, small-scale coastal fishing communities that are exposed to extreme weather events, sea-level rise, and shifting marine resources.

253. (B) Rationalize fishing effort and eliminate the race to fish
State intervention using Individual Transferable Quotas is a market-based management approach. By allocating secure, long-term shares of the total allowable catch to individual fishers or companies, this system aims to rationalize overall fishing effort, eliminate the competitive race to fish, improve vessel safety, and encourage fishers to protect the shared stock.

254. (B) 24 nautical miles
Under the United Nations Convention on the Law of the Sea, a coastal state can draw a straight baseline to enclose a bay, provided the bay meets specific geographic criteria. The treaty limits the maximum length of this closing line to twenty-four nautical miles, landward of which the waters are classified as internal waters.

255. (B) Over-exploitation
Under the United Nations Convention on the Law of the Sea, coastal states exercise sovereign rights over living resources within their exclusive economic zones. This authority is coupled with a legal duty; coastal states must use the best scientific evidence available to ensure that these resources are not endangered by over-exploitation or habitat degradation.

256. (B) Resource conservation by prohibiting destructive fishing methods
The Indian Fisheries Act of 1897 holds historical significance as the first central legislation in India to address aquatic resource conservation. Rather than managing trade, the act focused on protecting fish stocks by prohibiting highly destructive harvesting methods, specifically the use of explosives and chemical poisons to catch or destroy fish in national waters.

257. (B) Territorial waters only
State Marine Fishing Regulation Acts are state-level legislations in India. Consequently, the seasonal fishing closures and monsoon trawl bans implemented under these acts apply strictly to territorial waters, which extend up to twelve nautical miles from the baseline, as state jurisdiction does not extend into the offshore exclusive economic zone.

258. (B) Empowering Indian entrepreneurs and upgrading domestic capacity
Following the recommendations of the Murari Committee in 1995, India's deep-sea fishing policy underwent a major shift. The government phased out foreign joint ventures and redirected national policy toward empowering Indian entrepreneurs, providing subsidies to upgrade the capacity of the domestic fleet, and encouraging local fishers to exploit offshore resources sustainably.

259. (B) Nutrient loads and suspended solids before discharge
Under the Environmental Protection Act of 1986, large-scale coastal aquaculture facilities are required to operate effluent treatment plants. These treatment systems are mandatory to reduce high nutrient loads, organic matter, and suspended solids from pond wastewater before it is discharged into public coastal waters, preventing eutrophication and protecting estuarine habitats.

260. (B) Wildlife (Protection) Act (1972)
Sea fans, belonging to the order Gorgonacea, are slow-growing marine organisms that form critical structural habitats in coral reef ecosystems. To protect these vulnerable octocorals from exploitation and the international curio trade, they are listed under Schedule I of India's Wildlife Protection Act of 1972, prohibiting their harvest, possession, or sale.

261. (A) Customs Department and Coast Guard
The Maritime Zones of India Act of 1981 designates specific national agencies to enforce its provisions and protect sovereign marine resources. The primary enforcement personnel authorized to detect, board, and apprehend non-

it cannot obtain or retain the MSC ecolabel for its products, although it can still operate under domestic laws.

242. (B) Flag state of the catching vessel
The European Union Catch Certificate requirement is a key trade measure designed to combat illegal fishing. It shifts the burden of proof regarding the legality of harvested fish to the flag state of the catching vessel, which must formally validate the catch certificate to confirm that the seafood was caught in compliance with international conservation laws.

243. (B) The posting of reasonable bond or other security
Under Article seventy-three of the United Nations Convention on the Law of the Sea, a coastal state can take enforcement measures within its exclusive economic zone. However, the treaty specifies that arrested foreign vessels and their crews must be promptly released by the coastal state upon the posting of a reasonable bond or other financial security.

244. (B) Undermine the effectiveness of regional conservation and management measures
The United Nations Fish Stocks Agreement places clear duties on flag states to manage their vessels in international waters. Flag states are required to take all necessary measures to ensure that vessels flying their flag do not engage in unauthorized fishing or undermine the effectiveness of conservation and management measures established by Regional Fisheries Management Organizations.

245. (B) Overfishing and economic inefficiency
The FAO Code of Conduct for Responsible Fisheries urges states to monitor and manage overall fishing capacity. This regulatory measure is designed to prevent overfishing and avoid economic inefficiency in the sector. By matching fleet capacity with the reproductive capacity of fish stocks, states can support long-term biological sustainability and protect fisher incomes.

246. (B) The state that listed the species in Appendix III
Under the rules of CITES, species listed in Appendix III are protected within the jurisdiction of at least one country. An export permit is required for international trade in these specimens only if the shipment originates from the specific state that requested the species' listing, ensuring that trade does not undermine that nation's conservation laws.

247. (B) Migration
Under the Convention on Migratory Species, contracting parties have specific obligations to protect endangered wildlife. For species listed in Appendix I, range states are required to conserve and restore critical habitats and take steps to mitigate or remove physical obstacles that impede the animals' seasonal and predictable transboundary migration across their natural ranges.

248. (B) Ecology, botany, zoology, limnology, or hydrology
To be designated as a Wetland of International Importance under the Ramsar Convention, a site must possess significant ecological value. The wetland must meet specific international criteria based on its unique biology, botany, zoology, limnology, or hydrology, demonstrating its critical role in conserving biodiversity and supporting vulnerable wetland-dependent species.

249. (B) International Maritime Organization (IMO)
The MARPOL Convention is an international treaty managed by the International Maritime Organization. The IMO is the specialized United Nations agency responsible for developing and updating the technical guidelines and standards that help ship operators, port states, and flag registries implement Annex V regulations to prevent garbage pollution from vessels.

250. (B) The commercial whaling moratorium remains in place
The International Whaling Commission developed the Revised Management Procedure to calculate sustainable catch limits for commercial whaling based on scientific data. However, this management tool has not been implemented for commercial harvesting because the global moratorium on commercial whaling, established in 1986, remains in place and is supported by a majority of member states.

251. (B) Within the specific timeframe stipulated in the resolution, usually 120 days
Under the agreement establishing the Indian Ocean Tuna Commission, member states

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management authority of the exporting country, which confirms that the harvest was legal and sustainable.

272. (C) Entire range
The overarching goal of the Convention on Migratory Species is to conserve transboundary wildlife. The treaty aims to protect terrestrial, marine, and avian migratory species, as well as their habitats, throughout their entire geographic range, requiring coordinated conservation and management efforts among all range states along the animals' migration pathways.

273. (B) National land-use planning
The Ramsar Convention on Wetlands encourages contracting parties to adopt a holistic approach to conservation. Under the treaty, member states are urged to integrate wetland conservation and sustainable management principles into their broader national land-use planning and environmental policies, preventing the drainage and degradation of these fragile aquatic ecosystems.

274. (C) The continued capture of marine life by discarded or lost fishing gear
In the context of marine conservation and MARPOL Annex V, ghost fishing refers to the accidental capture and mortality of marine animals. This occurs when discarded, lost, or abandoned synthetic fishing nets, traps, and lines continue to float in the ocean, trapping fish, marine mammals, and turtles without any human control.

275. (B) Satisfies nutritional and cultural needs without threatening stocks
The International Whaling Commission allows aboriginal subsistence whaling because this harvesting practice is designed to satisfy the documented nutritional and cultural needs of specific indigenous communities. The commission regulates these hunts using separate scientific assessments to ensure that the catch limits do not threaten the recovery of the whale populations.

276. (B) Stock assessments and fisheries data submitted by member states
The scientific committee of the Indian Ocean Tuna Commission provides resource management advice to member states. This scientific guidance is based on rigorous stock assessments and fisheries-dependent data, including catch weights and fishing effort, which are regularly submitted by member nations and analyzed by independent scientists to determine sustainable harvest limits.

277. (B) Eco-friendly and fuel-efficient fishing technologies
The Bay of Bengal Programme Inter-Governmental Organisation supports artisanal and small-scale coastal fishers by promoting sustainable harvesting practices. The organization encourages the adoption of eco-friendly and fuel-efficient fishing technologies, such as selective gears and low-emission engines, which help fishers reduce their operating costs and minimize their environmental footprint on the marine ecosystem.

278. (B) Leave fish in the water to reproduce
The Tragedy of the Commons model highlights a key economic challenge in open-access fisheries. Without regulatory oversight, individual fishers have no economic incentive to leave fish in the water to reproduce. They recognize that any fish they do not harvest will simply be caught by competitors, leading to a race to fish and overexploitation.

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279. (C) Baseline
Under the United Nations Convention on the Law of the Sea, maritime jurisdictional zones are defined by specific seaward distances. The outer limit of the territorial sea, which can extend up to twelve nautical miles, is measured from the baseline of the coastal state, separating territorial waters from the adjacent contiguous zone.

280. (A) Drawing a median line or reaching a bilateral delimitation agreement
Under the United Nations Convention on the Law of the Sea, if the distance between the coastlines of two opposite or adjacent states is less than four hundred nautical miles, their exclusive economic zones overlap. In such cases, the boundary is determined by drawing a median line or reaching a formal bilateral delimitation agreement.

281. (A) Section 4
The Indian Fisheries Act of 1897 includes clear statutory prohibitions against destructive harvesting practices to protect aquatic resources. Section four of this historic legislation specifically outlaws the use of dynamite or other chemical

explosives in any water body with the intent to catch or destroy fish, carrying penalties of fines and potential imprisonment.

282. (B) Prevent mass capture of juvenile pelagic shoals and resource depletion
State Marine Fishing Regulation Acts strictly regulate the use of purse seine nets within territorial waters. This management measure is designed to prevent the mass capture of entire shoals of pelagic fish, including juvenile specimens, which can lead to rapid resource depletion and negative impacts on the local marine food web.

283. (B) 12 nautical miles (territorial waters))
India's deep-sea fishing policies mandate that domestic industrial vessels must target resources beyond nearshore waters. These larger vessels are required to operate beyond twelve nautical miles from the baseline, which marks the outer limit of state territorial waters, reserving nearshore resources for traditional, small-scale coastal fishers and protecting shallow spawning habitats.

284. (B) Antibiotics and pharmacologically active substances in shrimp farms
Under the Environmental Protection Act of 1986, coastal aquaculture authorities regulate chemical usage in the farming sector. These rules strictly control the use of antibiotics, veterinary drugs, and other pharmacologically active substances in shrimp and fish farms, preventing the contamination of surrounding coastal waters and reducing the risk of antibiotic resistance.

285. (B) Hunting, possessing, or trading them without explicit authorization
The Wildlife Protection Act of 1972 provides strict legal protection to endangered wildlife in India. For species listed under Schedule I, such as sea cucumbers and whale sharks, any unauthorized hunting, capture, possession, or commercial trade of the specimens is classified as a serious criminal offense, carrying mandatory penalties of fines and imprisonment.

286. (B) Designated Indian courts
Under the Maritime Zones of India Act of 1981, unauthorized foreign fishing vessels apprehended within national waters are subject to judicial prosecution. The adjudication of these confiscated vessels, along with their physical gear and catches, is conducted by designated Indian courts, which determine the legal penalties and forfeiture of the property.

287. (A) Granting joint ownership of intellectual property rights
The Biological Diversity Act of 2002 outlines various options to achieve equitable sharing of benefits from commercializing biological resources. These benefits can include monetary payments, technology transfer, or granting joint ownership of intellectual property rights to the local communities and traditional knowledge holders who conserve and manage the genetic resources.

288. (A) High Tide Line landward up to a specified distance (e.g., 200 meters))
Under Coastal Regulation Zone notifications, CRZ-III designated areas contain a specific protective zone adjacent to the shoreline. This No Development Zone is measured landward from the High Tide Line up to a designated distance, typically 200 meters, within which new construction is strictly prohibited to protect the beach from environmental hazards.

289. (B) Monitoring, Control, and Surveillance
The National Policy on Marine Fisheries of 2017 emphasizes the implementation of MCS to ensure compliance with fisheries regulations. MCS stands for Monitoring, Control, and Surveillance, which represents the entire range of activities, including vessel registration, satellite tracking, boardings, and patrols, used to manage fishing effort and combat illegal fishing.

290. (B) Ensuring quality for international export markets
The Marine Products Export Development Authority is authorized to establish standards and specifications for marine products in India. The primary purpose of this regulatory power is to ensure the safety and quality of seafood destined for international export markets, helping exporters comply with strict food safety regulations in importing countries.

291. (B) Accurately tracked and segregated from uncertified products at every processing stage
Under the Marine Stewardship Council certification program, seafood traceability is maintained throughout the supply chain. Chain of custody rules require that certified seafood is

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accurately tracked and physically segregated from uncertified products at every stage, including processing, distribution, and retail packaging, ensuring the product's sustainable origin.

292. (B) Flag state of the catching vessel
The European Union Catch Certificate is a key trade document used to combat illegal fishing. To be legally recognized for seafood imports into the European market, the certificate must be formally validated by the competent authority of the flag state of the catching vessel, confirming that the catch complied with conservation regulations.

293. (B) Highly migratory species
Article sixty-four of the United Nations Convention on the Law of the Sea addresses the conservation of highly migratory species, such as tuna and billfish. The treaty mandates that coastal states and other nations fishing for these species in a region must cooperate, either directly or through appropriate international organizations, to ensure sustainable management.

294. (B) Managing straddling and highly migratory fish stocks
The United Nations Fish Stocks Agreement establishes Regional Fisheries Management Organizations as the primary international mechanism for ocean governance. These regional bodies are responsible for coordinating cooperation among states to manage and conserve straddling and highly migratory fish stocks that cross multiple maritime boundaries, utilizing scientific data to set catch limits.

295. (B) Coastal area management programs
The FAO Code of Conduct for Responsible Fisheries encourages states to adopt a holistic approach to resource governance. The code promotes the integration of fisheries management and conservation policies into broader coastal area management programs, helping address the impacts of land-based pollution, urbanization, and habitat destruction on marine ecosystems.

296. (B) Not primarily commercial (e.g., scientific research))
Under CITES regulations, international trade in species listed in Appendix I is strictly controlled because these taxa are threatened with extinction. Import permits are issued only when the importing management authority is satisfied that the specimens will not be used for primarily commercial purposes, such as scientific research or conservation breeding.

297. (B) Conserve and restore habitats important to the species
Under the Convention on Migratory Species, contracting parties that are range states for migratory animals have specific conservation obligations. For species listed in Appendix I, these nations are required to conserve and restore critical habitats, mitigate physical obstacles to migration, and control factors that endanger the species, supporting their survival.

298. (B) Are threatened by technological developments, pollution, or other human interference
Wetlands listed under the Ramsar Convention are added to the Montreux Record under specific environmental conditions. This registry is used to identify sites where the ecological character of the wetland has changed, is changing, or is highly likely to change due to the impacts of technological development, pollution, or other human-induced interference.

299. (A) Special Areas (e.g., the Mediterranean Sea)
Under MARPOL Annex V, the strictest regulations on garbage and waste discharge are enforced within designated Special Areas. These maritime regions, such as the Mediterranean Sea, Baltic Sea, and Red Sea, possess unique oceanographic and ecological characteristics that make them highly vulnerable to pollution, requiring complete bans on waste disposal from ships.

300. (B) Pause commercial whaling to allow whale stocks to recover and undergo scientific assessment
The primary objective of the International Whaling Commission's commercial whaling moratorium, implemented in 1986, was to address the critical decline of whale populations. This measure established a temporary pause on commercial harvesting to allow depleted stocks to recover and provide scientists with time to conduct comprehensive ecological assessments of whale status.

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